UNITED STATES DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

DRAFT SPECIFICATION FAA-E-2937A

CATEGORY I LOCAL AREA AUGMENTATION SYSTEM GROUND FACILITY

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1. SCOPE

1.1 IDENTIFICATION

This specification establishes the performance requirements for the Federal Aviation Administration (FAA) Category I (CAT I) 1 Local Area Augmentation System (LAAS) Ground Facility (LGF). Requirements contained within this specification are the basis to augment the Global Positioning System (GPS) to provide precision approach capability down to Category I minimums, area navigation (RNAV), and other operations using differentially corrected positioning service. The performance requirements are consistent with those requirements defined in the Requirements Document for the GPS Local Area Augmentation System (GPS/LAAS) (FAA), the Minimum Aviation System Performance Standards (MASPS) for the LAAS (RTCA/DO-245), and the Minimum Operational Performance Standards (MOPS) for the LAAS (RTCA/DO-253A). Some functional requirements are embedded in the LGF performance requirements.

1.2 SYSTEM OVERVIEW

The LGF is a safety-critical system consisting of the hardware and software that augments the GPS Standard Positioning Service (SPS) providing precision approach and landing capability. The current GPS positioning service provided is insufficient to meet the integrity, continuity, accuracy, and availability demands of precision approach and landing navigation. The LGF, using differential GPS concepts, augments the GPS SPS in order to meet these requirements.

As an integrated system, the GPS/LAAS is maintained in three separate segments (illustrated in Figure 1-1: a) the LGF; b) the Space Segment; and c) the Airborne Subsystem. The LGF provides differential corrections, integrity parameters, and precision approach pathpoint data that are broadcast via a Very High Frequency (VHF) Data Broadcast (VDB) to the Airborne Subsystem for processing. The Space Segment provides the LGF and Airborne Subsystem with GPS and Satellite-Based Augmentation System (SBAS) ranging signals and orbital parameters. The Airborne Subsystem applies the LGF corrections to the GPS and SBAS ranging signals to obtain position with the required accuracy, integrity, continuity, and availability. The differentially corrected position is used, along with pathpoint data, to supply deviation signals to drive appropriate aircraft systems supporting terminal area and precision approach operations. Using the position output from the airborne receiver, LAAS also enables terminal area operations by aircraft equipped with RNAV capability.

The LGF provides detailed status information to support maintenance and air traffic requirements. Status and control capabilities are executed through either a Maintenance Data Terminal (MDT) or a Remote Maintenance Data Terminal (RMDT). The MDT display is provided as part of the LGF, while the RMDT will allow for future integration with a remote maintenance monitoring capability. Additionally, the LGF sends status information to FAA Air Traffic Control (ATC) via an Air Traffic Control Unit (ATCU). The ATCU provides air traffic controllers with LGF status information and runway control capabilities. For maintenance purposes, LGF status information is available via the Local Status Panel (LSP) and the Remote Status Panel (RSP).

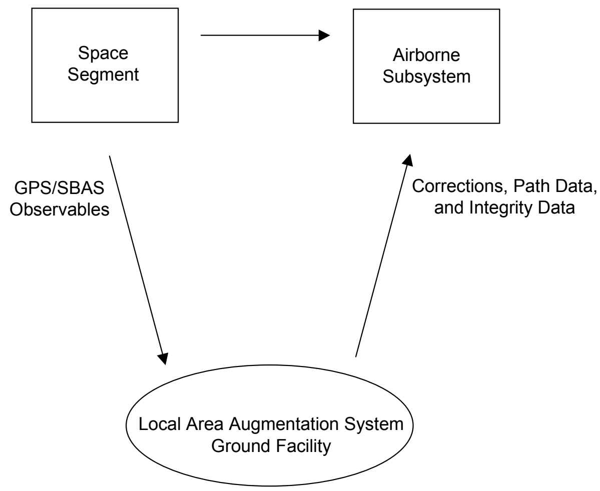

Figure 1-1. Local Area Augmentation System

1.3 DOCUMENT OVERVIEW

The format of this document complies with FAA-STD-005E, MIL-STD-961D, and MIL-STD-962C. Section 1 provides a general overview of the LGF and a high-level introduction to the requirements for implementing operational satellite-based precision approach. Section 2 lists the documents from which requirements are referenced or derived. Section 3 contains the performance, functional, operational, and maintenance requirements for the LGF. Section 4 contains verification requirements for both hardware and software. Appendix A contains a reference to the LAAS MOPS (RTCA/DO-253A) of the Interference Environment. Appendix B is not utilized. Appendix C provides a Verification Requirements Traceability Matrix. Appendix D supplies a listing and expansion of acronyms. Appendix E provides information on the Special Conditions for Ground and Air. Appendix F supplies information on the operational environment to aid in proper integration with existing facilities and procedures. Appendix G provides the Integrity Risk and Continuity Risk Allocation trees. The definitions for the Final Approach Segment are located in Appendix H.

2. APPLICABLE DOCUMENTS

The following documents form a part of this specification and are applicable to the extent specified herein. In case of conflict between referenced documents and the contents of this specification, the contents of this specification shall take precedence.

2.1 GOVERNMENT DOCUMENTS

2.1.1 REGULATIONS

2.1.1.1 Federal Aviation Administration

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2.1.2 SPECIFICATIONS

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2.1.3 STANDARDS

2.1.3.1 Federal Aviation Administration

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Federal Aviation Administration. (1998). *Electrical power policy implementation at national airspace system facilities* (FAA Order 6950.2D). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (2000). *Federal aviation administration information systems security program* (FAA Order 1370.82). Washington, DC: U.S. Government Printing Office.

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2.2 NON-GOVERNMENT DOCUMENTS

International Civil Aviation Organization. (1999). *Ground based augmentation system standards and recommended practices*. Proceedings of the Global Navigation Satellite System Panel (GNSSP) Third Meeting, Montreal, Canada 12 to 23 April 1999, Report on Agenda Item 1.

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3. REQUIREMENTS

This section prescribes functional and performance requirements. Functional requirements, and their groupings, do not imply allocation of functionality to hardware and software design. When required to establish interoperability, specific design and/or algorithms are specified. Certain other design-specific requirements are given, as necessary, to ensure the accuracy, continuity, availability, and integrity needed to support minimum performance levels required to operate within the U.S. National Airspace System (NAS). All requirements listed in the following sections shall be met prior to Government acceptance.

3.1 LGF GENERAL REQUIREMENTS

3.1.1 COVERAGE VOLUME

The LGF approach coverage volume is defined as the volume of airspace where the LGF meets the signal strength, accuracy, integrity, continuity, and availability requirements of this specification. The LGF provides the level of service necessary to support Category I and meets the integrity to support terminal area operations. The VDB broadcasts an omnidirectional signal to accommodate terminal and surface navigation, surveillance, and other users requiring Differentially Corrected Positioning Service information, but may be impacted by the existence of terrain or obstacles on or around the airport.

3.1.1.1 Approach Coverage Volume

When the installed on-channel assigned power is set to the lower monitor limit, the LGF shall meet the minimum field-strength requirements of Section 3.2.2.4 for each Category I approach. The approach (Figure 3-1a) and missed approached (Figure 3-1b) coverage volume shall be:

a. Approach:

    1. Laterally beginning at 450 ft each side of the Landing Threshold Point (LTP) or Fictitious Threshold Point (FTP) and projecting out ± 35° either side of the final approach path to a distance of 20 nm from the LTP/FTP.

    2. Vertically, within the lateral region, between 10,000 ft Above Ground Level (AGL) and the plane inclined at 0.9° originating at the LTP/FTP and down to 50 ft above the runway.

b. Missed Approach:

1. Laterally ± 1.0 nm either side of the runway centerline from the approach end of the runway to 4.0 nm beyond the departure end of the runway.

2. Vertically, within the lateral region, between 10,000 ft AGL and the plane inclined at 0.9° above the horizontal plane and passing 50 ft above the LTP/FTP level along a horizontal plane to the Flight Path Alignment Point (FPAP), then continuing along a horizontal plane inclined at 0.9°.

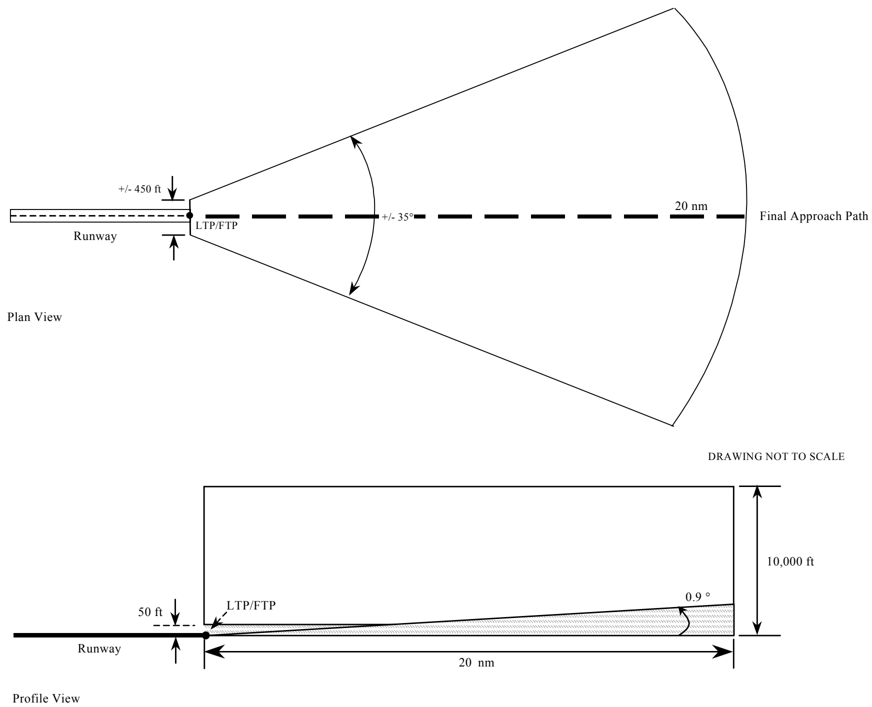

Figure 3-1a. CAT I Approach Coverage Volume

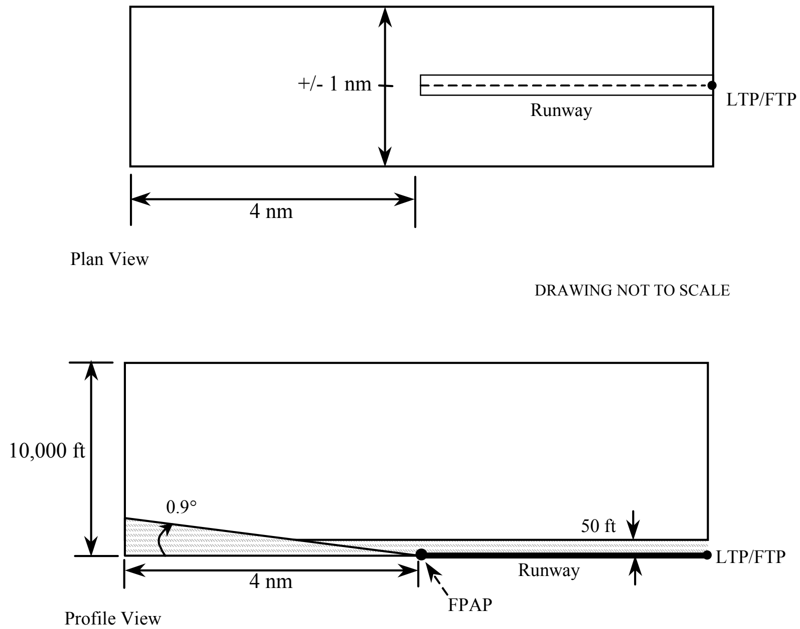

Figure 3-1b. CAT I Missed Approach Coverage Volume

3.1.1.2 VDB Coverage Volume

3.1.1.2.1 Lower Alarm Limit

The LGF shall meet the minimum field-strength requirements of Section 3.2.2.4 when there is no blockage of line-of-sight due to local terrain or obstacles, when the on-channel power is set to the lower alarm limit, and within, at least, the following minimum coverage volume:

a. Laterally:
   1. Encompassing 360° around the VDB antenna,
   2. Beginning at 100 m,
   3. Extending to 23 nm,

b. Vertically, within the lateral region:
   1. Within 3 nm of the VDB antenna, between the horizontal plane 12 ft above the ground at the antenna and a conical surface inclined at not less than 85° above the horizontal plane, up to a height of 10,000 ft and
   2. From 3 nm to 23 nm, between 10,000 ft AGL and a conical surface that is inclined at 0.9° above the horizontal plane with an origin 274 ft below the ground at the antenna.

3.1.1.2.2 Maximum Field Strength

The LGF shall not exceed the maximum field strength requirements of Section 3.2.2.4 in any direction beginning at 200 m from the VDB antenna within the coverage volume specified in Section 3.1.1.2.1.

Figure 3-2 depicts a representation of the VDB coverage volume.

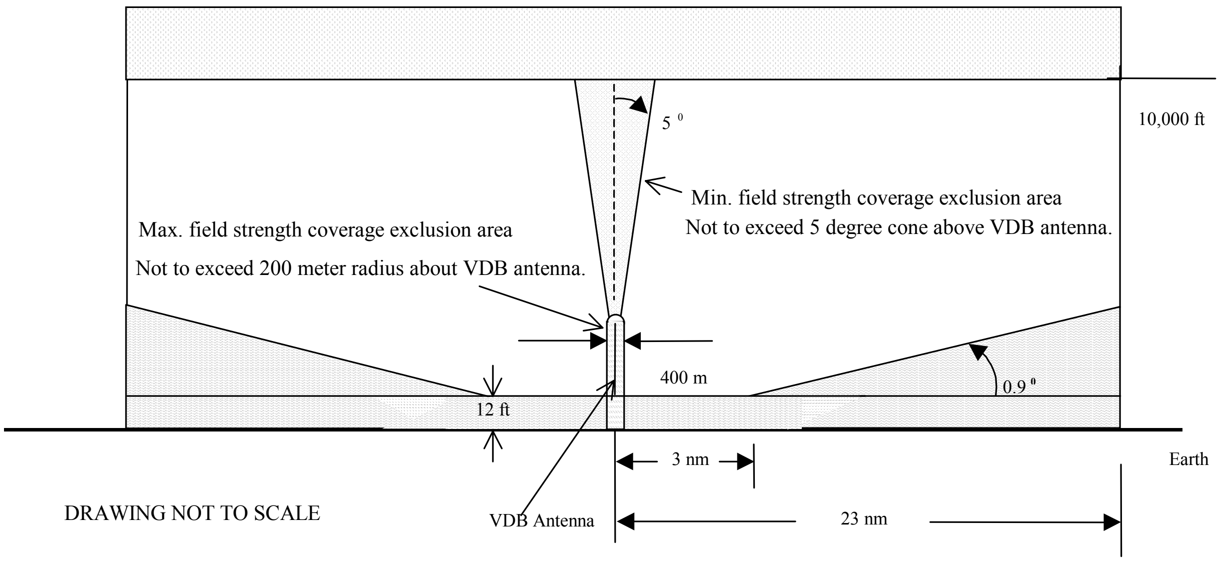

Figure 3-2. Local Area Augmentation System Ground Facility Coverage Volume

3.1.2 INTEGRITY

The LGF is required to meet the integrity to support Category I precision approach, area navigation, and other operations that use differentially corrected positioning service. Some of the integrity allocations have different requirements for the operations and are therefore specified separately in the subsections below.

3.1.2.1 LGF Integrity Risk

3.1.2.1.1 Category I Precision Approach

The probability that the LGF transmits Misleading Information (MI) for 3 seconds or longer due to a ranging source or LGF failure, when operating within the Radio Frequency Interference (RFI) environment defined in Appendix A, shall not exceed 1.5×10^{-7} during any 150-second approach interval. Misleading information is defined as broadcast data that results in a position error exceeding the protection level and ephemeris error bound for any user that complies with RTCA/DO-253A. Ranging source failures shall include:

a. Signal deformation as defined in Appendix E, with a prior probability of 4.2×10^{-6} per approach per satellite;

b. Signal levels below those specified in Section 2.3.4 of the GPS SPS Signal Specification, with a prior probability of 4.2×10^{-6};

c. Code/carrier divergence, with a prior probability of 4.2×10^{-6} per approach per satellite;

d. Excessive pseudorange acceleration, such as step or other rapid change, with a prior probability of 4.2×10^{-6} per approach per satellite;

e. Erroneous broadcast of GPS ephemeris data, with a prior probability of 4.2×10^{-6} per approach per satellite.

The LGF failures shall include the broadcast of erroneous data, or that one or more failures exist that affect the smoothed pseudorange corrections (PR_{sca}) from more than one Reference Receiver (RR). Erroneous data is defined to be any broadcast parameter that fails to be computed and broadcast in accordance with Section 3.2.1.

Note: In conforming to the integrity risk assigned to the LGF, the broadcast integrity parameters (σ_{pr_gnd}, σ_{iono}, P, K-values, Refractivity Index, Scale Height, and Refractivity Uncertainty) must be defined to ensure proper operation under fault-free conditions (both system and local environment).

3.1.2.1.2 Differentially Corrected Positioning Service

The probability that the LGF transmits Misleading Information (MI) for 3 seconds or longer due to a ranging source or LGF failure, when operating within the RFI environment defined in Appendix A, shall not exceed 9.9×10^{-8} during any 1-hour period. Misleading information is defined as broadcast data that results in a position error exceeding the protection level and ephemeris error bound for any user that complies with RTCA/DO-253A. Ranging source failures shall include:

a. Signal deformation as defined in Appendix E, with a prior probability of 1×10^{-4} per hour per satellite;

b. Signal levels below those specified in Section 2.3.4 of the GPS SPS Signal Specification, with a prior probability of 1×10^{-4} per hour per satellite;

c. Code/carrier divergence, with a prior probability of 1×10^{-4} per hour per satellite;

d. Excessive pseudorange acceleration, such as a step or other rapid change, with a prior probability of 1×10^{-4} per hour per satellite;

e. Erroneous broadcast of GPS ephemeris data, with a prior probability of 1×10^{-4} per hour per satellite.

The LGF failures shall include the broadcast of erroneous data, or that one or more failures exist that affect the smoothed pseudorange corrections (PR_{sca}) from more than one Reference Receiver (RR).

Note: In conforming to the integrity risk assigned to the LGF, the broadcast integrity parameters (σ_{pr_gnd}, σ_{iono}, P, K-values, Refractivity Index, Scale Height, and Refractivity Uncertainty) must be defined to ensure proper operation under fault-free conditions (both system and local environment).

3.1.2.2 Protection Level Integrity Risk

3.1.2.2.1 Category I Precision Approach

The probability that the LGF transmits Misleading Information (MI) for 3 seconds or longer, in the absence of a ranging source or LGF failure, shall not exceed $5x10^{-8}$ during any 150-second approach interval. Ranging source failures and LGF failures are defined in 3.1.2.1.1.

3.1.2.2.2 Differentially Corrected Positioning Service

The probability that the LGF transmits Misleading Information (MI) for 3 seconds or longer, in the absence of a ranging source or LGF failure, shall not exceed $1x10^{-9}$ in any 1-hour interval. Ranging source failures and LGF failures are defined in 3.1.2.1.2.

3.1.2.3 Integrity in the Presence of RFI

The LGF shall not broadcast MI due to RFI that exceeds the levels in Appendix A.

3.1.2.4 Latent Failures

Compliance with requirements in Sections 3.1.2.1 and 3.1.2.2, shall account for the probability that the associated monitors have failed.

3.1.3 CONTINUITY

3.1.3.1 VDB Transmission Continuity

The probability of an unscheduled interruption of the VDB transmission, where messages are not transmitted in accordance with Section 3.2.2 for a period equal to or greater than 3 seconds, shall not exceed $1x10^{-6}$ in any 15-second interval. On average, the LGF shall transmit at least 999 correctly formatted messages out of 1000 consecutive messages.

3.1.3.2 Reference Receiver and Ground Integrity Monitoring Continuity

The probability that the number of valid B-values is reduced to 3 for any valid ranging source within the reception mask (Section 3.2.1.2.6.1) shall not exceed $2.3x10^{-6}$ in any 15-second interval.

3.1.3.3 Latent Failures Affecting Continuity

If redundant equipment is used to meet the requirements in Sections 3.1.3.1 and 3.1.3.2, compliance shall account for the probability that the redundant equipment has failed.

3.1.4 STATES AND MODES

3.1.4.1 States

The LGF shall have the following two states:

a. LGF On: Main or supplemental power is applied to the LGF equipment and

b. LGF Off: No power is applied to the LGF equipment.

Only one state shall exist at a time.

3.1.4.2 Modes

The LGF shall have the following modes while in the On State:

a. Normal,

b. Not Available, and

c. Test.

There are no modes when the LGF is in the Off State.

Only one mode shall exist at a time. The LGF shall automatically transition from Normal to Not Available when there is an alarm condition.

3.1.4.3 Normal Mode

The LGF shall be in the Normal Mode when Test Mode has not been commanded and an alarm does not exist. The Normal Mode shall include the following conditions, actions and transition criteria:

a. Conditions:
   1. Alert (Section 3.1.5.1.2)
   2. Service Alert (Section 3.1.5.1.3)
   3. Constellation Alert (Section 3.1.5.1.4)

b. Actions:
   1. Approach Control (Sections 3.3.2.3.15 & 3.3.2.4.1)
   2. Periodic Maintenance (Section 3.3.1.8.4.2)
   3. Non-intrusive diagnostics (Section 3.3.2.3.19)
   4. LRU Replacement (Section 3.3.1.8.4.1)
   5. Data Recording (Section 3.3.3)
   6. Status monitoring (Sections 3.3.2.3.2, .3, .4, .7 - .9, .12, .14, .16, .18, & .20)
   7. User ID and password change (Section 3.3.1.9.2.3)

8. Adjustment storage (Section 3.3.2.3.21)
9. Fault recovery (Section 3.1.5.1.1)

c. Transition Criteria:
   1. Entering Normal Mode:
      a) Enter Normal Mode from Off State (power applied)
      b) Enter Normal Mode from Test Mode (Normal Mode commanded)
      c) Enter Normal Mode from Not Available Mode (Auto restart or manual restart commanded)
   2. Exiting Normal Mode:
      a) Exit Normal Mode to Not Available Mode (alarm)
      b) Exit Normal Mode to Test Mode (Test Mode commanded)

3.1.4.4 Not Available Mode

The LGF shall transition from Normal Mode to the Not Available Mode when an alarm exists and when it is not in Test Mode. The LGF shall remain in Not Available Mode until the alarm is cleared or the LGF is placed in Test Mode. The Not Available Mode shall include the following conditions, actions and transition criteria:

a. Condition:
   1. Alarm (Section 3.1.5.1.5)

b. Actions:
   1. Automatic Restart (Section 3.1.5.1.5.1)
   2. States and modes display (Section 3.1.4)
   3. System power display (Section 3.3.2.3.7)
   4. System events recording (Section 3.3.3.1)

c. Transition Criteria:
   1. Entering Not Available Mode:
      a) Enter Not Available Mode from Normal Mode (alarm)
      b) Enter Not Available Mode from Test Mode
   2. Exiting Not Available Mode:
      a) Exit Not Available Mode to Normal Mode (auto restart or manual restart commanded)
      b) Exit Not Available Mode to Test Mode (Test Mode commanded)

3.1.4.5 Test Mode

The LGF shall enter Test Mode when undergoing maintenance or test. While in Test Mode, the VDB shall be capable of broadcasting all message types as if in the Normal or Not Available Mode. The LGF shall enter Test Mode when commanded by a maintenance specialist. The Test Mode shall include the following conditions, actions and transition criteria:

a. Conditions:
   1. Alert (Section 3.1.5.1.2)
   2. Service Alert (Section 3.1.5.1.3)
   3. Constellation Alert (Section 3.1.5.1.4)
   4. Alarm (Section 3.1.5.1.5)

b. Maintenance and test actions:
   1. Restart the LGF (Section 3.3.2.3.1)
   2. Intrusive and non-intrusive diagnostic control (Section 3.3.2.3.19)
   3. Trouble shooting (Section 3.3.1.7)
   4. Site specific parameter change (Sections 3.3.2.3.6 & 3.3.2.3.13)
   5. Alert, service alert, constellation alert, and alarm threshold change (Section 3.3.2.3.10)
   6. Redundant equipment status change (Section 3.3.2.3.17)
   7. Monitor by-pass (Section 3.3.2.3.11)
   8. VDB by-pass (Section 3.3.2.3.5)
   9. Approach control (Section 3.3.2.3.15 & 3.3.2.4.1)
   10. Periodic maintenance (Section 3.3.1.8.4.2)
   11. LRU replacement (Section 3.3.1.8.4.1)
   12. Data recording (Section 3.3.3)
   13. Status monitoring (Sections. 3.3.2.3.2, .3, .4, .7 - .9, .12, .14, .16, .18, & .20)
   14. User ID and password change (Section 3.3.1.9.2.3)
   15. Adjustment storage (Section 3.3.2.3.21)
   16. Fault recovery (Section 3.1.5.1.1)

c. Transition Criteria:
   1. Entering Test Mode:
      a) Enter Test Mode from Normal Mode (Test Mode commanded)
      b) Enter Test Mode from Not Available Mode
   2. Exiting Test Mode:

a) Exit Test Mode to Normal Mode (Normal Mode commanded)

b) Exit Test Mode to Not Available Mode

Upon exiting the Test Mode, the LGF shall revert to either the Normal or Not Available Mode, depending on the existence of an alarm.

The following figure, Figure 3-3, illustrates the allowable conditions and actions within LGF States and Modes.

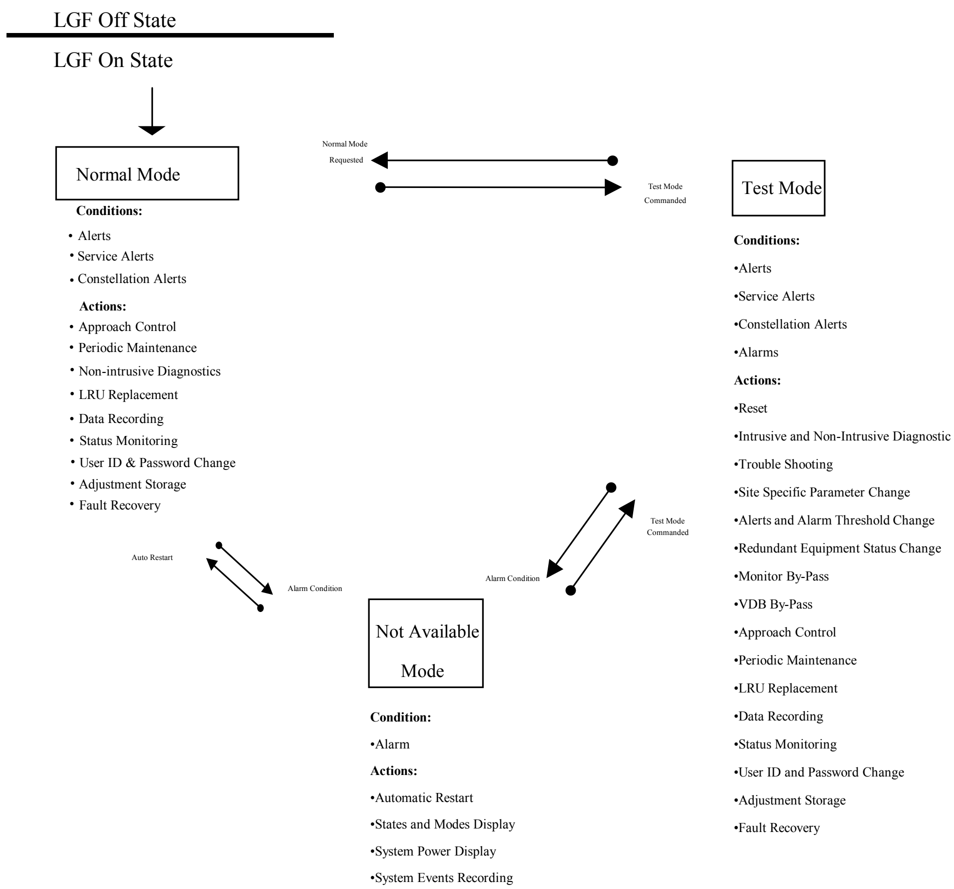

Figure 3-3. Local Area Augmentation System: States and Modes

3.1.5 EXECUTIVE MONITORING

3.1.5.1 Fault Monitoring

The LGF shall take the identified action for each fault condition identified in Table 3-1 and Table 3-2. Additional performance checks and system monitors may be required to meet the integrity requirements of Sections 3.1.2.1 and 3.1.2.2.

Table 3-1. Fault Conditions and Actions

Section	Fault	Action
3.1.2.1.1(a)/ 3.1.2.1.2 (a)	Signal Deformation	Exclude Ranging Source from Type 1 Message Broadcast.
3.1.2.1.1(b)/ 3.1.2.1.2 (b)	Low Signal Power	Exclude Ranging Source from Type 1 Message Broadcast.
3.1.2.1.1(c)/ 3.1.2.1.2 (c)	Code/Carrier Divergence	Exclude Ranging Source from Type 1 Message Broadcast.
3.1.2.1.1(d)/ 3.1.2.1.2 (d)	Excessive Acceleration	Exclude Ranging Source from Type 1 Message Broadcast.
3.1.2.1.1(e)/ 3.1.2.1.2 (e)	Erroneous Ephemeris	Exclude Ranging Source from Type 1 Message Broadcast.
Corrections		
3.2.1.2.8.5.6.1 (a)	Filters not converged	Exclude PR_{mn}[1] from PRC and B-value calculation.
3.2.1.2.8.5.6.1 (b, c)	B-value exceeds limit	Exclude PR_{mn}[1] from PRC and B-value calculation.
3.2.1.2.8.5.6.1(d)	Pseudorange correction exceeds limit	Exclude ranging source from Type 1 Message broadcast.
3.2.1.2.8.6.1	Range Rate Correction (RRC) exceeds limit	Exclude ranging source from Type 1 Message broadcast.
3.2.1.2.8.6.1.1	Faulted σ_{rrc}	Exclude PR_{mn}[1] from PRC and B-value calculation, exclude ranging source from Type 1 Message broadcast, or exclude all measurements from RR from PRC and B-value calculation.
3.2.1.2.8.7.3	Faulted σ_{pr_gnd}	Exclude PR_{mn}[1] from PRC and B-value calculation, exclude ranging source from Type 1 Message broadcast, or exclude all measurements from RR from PRC and B-value calculation.
Data Broadcast		
3.2.3 (a)	Disagreement between transmitted data	Terminate VDB output.
3.2.3 (b)	On-channel assigned power exceeds limits	Terminate VDB output.
3.2.3 (c)	0.2% of messages not transmitted in last hour	Terminate VDB output.
3.2.3 (d)	No transmission for 3 seconds	Terminate VDB output.
3.2.3 (e)	Transmitted data outside of assigned Time Division Multiple Access (TDMA) time slots	Terminate VDB output.

[1] *Pseudorange (PR), where m indicates an individual RR and n indicates an individual ranging source.*

Table 3-2. Valid GPS and SBAS Navigation Data

Section	Fault	Action
3.2.1.2.8.3.1:		
(a)	Failed parity	Exclude GPS ranging source from Type 1 Message broadcast
(b)	Bad IODC	Exclude GPS ranging source from Type 1 Message broadcast
(c)	HOW bit 18 set to “1”	Exclude GPS ranging source from Type 1 Message broadcast
(d)	Data bits in subframes 1, 2, or 3 set to “0”	Exclude GPS ranging source from Type 1 Message broadcast
(e)	Subframes 1, 2, or 3 set to default	Exclude GPS ranging source from Type 1 Message broadcast
(f)	Preamble incorrect	Exclude GPS ranging source from Type 1 Message broadcast
(g)	Navigation data inconsistent between RRs	Exclude GPS ranging source from Type 1 Message broadcast
(h)	Almanac differs from ephemeris by more than 7000 m at any point	Exclude GPS ranging source from Type 1 Message broadcast
(i)	After valid corrections computed, PRC or PRC rate exceeds limit	Exclude GPS ranging source from Type 1 Message broadcast
(j)	Receive “Do Not Use” SBAS message	Exclude GPS ranging source from Type 1 Message broadcast
(k)	Ephemeris CRC changes and IODE does not	Exclude GPS ranging source from Type 1 Message broadcast
(l)	GPS PRN = 33 - 37	Exclude GPS ranging source from Type 1 Message broadcast
(m)	Satellite declared unhealthy	Exclude GPS ranging source from Type 1 Message broadcast
3.2.1.2.8.3.1	Ephemeris not consistent to within 250 m	Exclude GPS ranging source from Type 1 Message broadcast
3.2.1.2.8.3.2:		
(a)	Failed parity	Exclude SBAS ranging source from Type 1 Message broadcast
(b)	Navigation data inconsistent between RRs	Exclude SBAS ranging source from Type 1 Message broadcast
(c)	Almanac differs from ephemeris by more than 200 km at any point	Exclude SBAS ranging source from Type 1 Message broadcast
(d)	SBAS positions changes more than 0.12 m in 4 minutes	Exclude SBAS ranging source from Type 1 Message broadcast
(e)	No SBAS navigation message for 4 minutes	Exclude SBAS ranging source from Type 1 Message broadcast
(f)	After valid corrections computed, PRC or PRC rate exceeds limit	Exclude SBAS ranging source from Type 1 Message broadcast
(g)	Receive ‘Do Not Use” SBAS message	Exclude SBAS ranging source from Type 1 Message broadcast

3.1.5.1.1 Fault Recovery

Upon exclusion of a single measurement, ranging source, or RR, the LGF shall continue to monitor the excluded single measurement, ranging source, or RR. For ranging source faults and correction faults in Table 3-1, except as noted in Section 3.2.1.2.8.7.3, the LGF shall re-introduce the excluded single measurement, ranging source, or RR when the fault no longer exists.

3.1.5.1.2 Generation of Alerts

The LGF shall generate an alert upon detecting a fault that does not affect the ability of the system to meet the integrity requirements of Section 3.1.2. Faults shall include the ranging source and correction faults identified in Table 3-1, navigation data in Table 3-2, and environmental sensor conditions exceeding the limits defined in Sections 3.3.1.6.3, 3.3.1.6.4, 3.3.1.6.5, and 3.3.1.6.6. Alert thresholds shall be defined during the design process.

3.1.5.1.3 Generation of Service Alerts

A service alert is defined as a fault that affects LGF level of service and requires corrective maintenance. Service alert thresholds shall be defined during the design process.

3.1.5.1.3.1 Continuity Faults

A service alert shall be generated when the LGF is unable to ensure that the continuity requirements of Section 3.1.3 can be met due to a fault in any of the following items:

a. Main and standby Line Replaceable Units (LRUs),

b. Hardware components,

c. Internal firmware, and

d. Uninterruptible power supply.

3.1.5.1.3.2 Environmental Faults

A service alert shall be generated when the thresholds for the following environmental sensors are exceeded:

a. Intrusion detector (Section 3.3.1.6.1),

b. Smoke detector (Section 3.3.1.6.2),

c. Alternating Current (AC) power (Section 3.3.1.6.4), and

d. Inside temperature (Section 3.3.1.6.5).

3.1.5.1.4 Generation of Constellation Alerts

A predictive constellation alert shall be generated 20 minutes ± 1 minute before a loss of service availability. A constellation alert shall be generated when the constellation no longer supports CAT I service. Only losses of service predicted to be longer than 1 minute shall cause a constellation alert. Constellation alerts shall be based on aircraft equipage with Aircraft

Accuracy Designator B LAAS avionics. The probability that an ATCU provides a constellation alert while service is available shall be less than $1x10^{-2}$. The probability that an ATCU is not provided with a constellation alert while service is not available shall be less than $1x10^{-2}$.

3.1.5.1.5 Generation of Alarms

The LGF shall generate an alarm when the integrity requirements of Section 3.1.2 cannot be guaranteed. The LGF shall generate an alarm when the VDB monitor has detected any fault identified in Section 3.2.3. When an alarm is generated, one of the following actions is taken:

a. When the requirements of Section 3.1.2.1 and 3.1.2.2 cannot be met, and when the system is not broadcasting erroneous data, the LGF shall broadcast the Type 1 Message with no measurement blocks.

b. When the system detects that it has broadcast erroneous data, the LGF shall terminate the VDB output.

c. When there is a fault detected in accordance with the requirements of Section 3.2.3, the LGF shall terminate the VDB output.

Alarm thresholds shall be defined during the design process.

3.1.5.1.5.1 Automatic Restart

The LGF shall attempt an automatic restart (Section 3.3.2.3.1), except as specified in 3.2.1.2.8.7.3, within 3 minutes following an alarm. If an alarm condition still exists following the restart attempt, restart shall be available only through manual command via the MDT.

3.1.6 SOFTWARE DESIGN ASSURANCE

All LGF software functions shall be compliant with the guidelines and objectives of the applicable software level specified in "Software Considerations in Airborne Systems and Equipment Certification" (RTCA/DO-178B, 1993).

All software developed for this system shall be in accordance with the C programming language specified in ANSI/ISO/IEC 9899-1999.

Note: The use of any other programming language will be subject to Government approval.

All software for the LGF shall be in accordance with guidelines for Year 2000 (Y2K) compliance. All software for the LGF shall accommodate any date between May 31, 2001 and December 31, 2049.

3.1.7 COMPLEX ELECTRONIC HARDWARE DESIGN ASSURANCE

Complex electronic hardware devices, including Application Specific Integrated Circuits (ASICs) and Programmable Logic Devices (PLDs), shall be produced with structured development, verification, configuration management, and quality assurance processes.

The level of production process rigor associated with complex electronic hardware shall be based on the contribution of the hardware to potential failure conditions as determined by the System Safety Assessment (SSA) process.

All hardware for the LGF shall follow Y2K guidelines. All hardware for the LGF shall accommodate any date between May 31, 2001 and December 31, 2049.

3.2 DATA BROADCAST

3.2.1 BROADCAST DATA REQUIREMENTS

All message types shall be in accordance with Section 2.4.1 of RTCA/DO-246B. The data format shall be in accordance with Section 2.4.2 of RTCA/DO-246B. All static parameters to be broadcast and default values shall be stored in the LGF Non-Volatile Memory (NVM). NVM storage shall be a minimum of 90 days without power applied.

3.2.1.1 LAAS Message Block

The LGF shall transmit the LAAS message block. The LAAS message block consists of the Message Block Header, the Message, and the Cyclic Redundancy Check (CRC).

3.2.1.1.1 Message Block Header

3.2.1.1.1.1 Message Block Identifier

The LGF shall set the Message Block Identifier Field to 1010 1010 when the LGF is not in Test Mode.

The LGF shall set the Message Block Identifier Field to 1111 1111 when the LGF is in Test Mode.

3.2.1.1.1.2 Ground Station Identification

The GBAS ID Field shall denote the LGF station Identification (ID) stored in LGF NVM.

3.2.1.1.1.3 Message Type Identifier

The Message Type Identifier Field shall only denote Message Type 1, 2, or 4.

3.2.1.1.1.4 Message Length

The Message Length Field shall denote the number of 8-bit words in the message block. The message length includes the header, the message, and the CRC field.

3.2.1.1.2 Message

The LGF shall transmit Message Types 1, 2, and 4.

3.2.1.1.3 Cyclic Redundancy Check

The CRC Field shall denote the CRC calculated on the message header and the message.

3.2.1.2 Type 1 Message – Differential Corrections

The LGF shall broadcast the Type 1 Message a minimum of once per frame. The LGF shall broadcast the Type 1 Message a maximum of once per slot per frame. If additional slots per frame are assigned so that the Type 1 Message is repeated, the modified Z-count shall not change, and the measurement block shall contain the same data.

The LGF shall broadcast the Type 1 Message formatted in accordance with Section 2.4.3 of RTCA/DO-246B. The LGF shall generate a ranging source measurement block for a minimum of 18 ranging sources when available within the reception mask. Broadcast of the Type 1 Message shall occur no later than 0.5 seconds after the time indicated by the Modified Z-count, corresponding to the corrections.

Note 1: All measurement types are of Type 0 as defined in RTCA/DO-246B.

Note 2: Additional slots that accommodate identical Type 1 messages are intended to support antenna diversity per Section 3.3.1.1.3.1. Antenna Diversity is defined as the use of multiple VDB antennas to provide the coverage requirement at a given airport.

3.2.1.2.1 Modified Z-Count

The Modified Z-count Field shall denote the reference time for all the message parameters in the Type 1 Message. The Modified Z-count for Type 1 Messages of a given measurement type shall advance every frame.

3.2.1.2.2 Additional Message Flag

The Additional Message Flag Field shall denote that additional messages are not provided.

3.2.1.2.3 Number of Measurements

The Number of Measurements Field shall denote the number of ranging source measurement blocks broadcast in the Type 1 Message.

3.2.1.2.4 Measurement Type

The Measurement Type Field shall denote the measurement type is GPS L1 C/A code.

3.2.1.2.5 Ephemeris CRC

The Ephemeris CRC Field shall denote the CRC for the ranging source associated with the first ranging source measurement block in the Type 1 Message.

3.2.1.2.6 Source Availability Duration

The Source Availability Duration Field shall denote the period that the ranging source is predicted to remain within the reception mask associated with the first ranging source measurement block relative to the Modified Z-count. The Source Availability Duration shall be +/- 60 seconds of the time that each ranging source becomes unavailable.

3.2.1.2.6.1 Reception Mask

The reception mask for the LGF shall define the region where corrections from ranging source signals are broadcast. The reception mask shall include all elevations from 5° to 90° and all azimuths from 0° to 360°, excluding blockage of line-of-sight, due to any obstacle protruding from the horizontal plane.

3.2.1.2.6.2 Azimuth/Elevation Sector Masking

The LGF shall have the capability to exclude measurements from the pseudorange correction calculation within an azimuth/elevation sector on a per RR basis. The resolution of the azimuth and elevation limits shall be 0.1 degrees.

3.2.1.2.7 Ephemeris Decorrelation Parameter (P)

The Ephemeris Decorrelation Parameter field shall characterize the impact of residual ephemeris errors due to spatial decorrelation. For every valid GPS ranging source, the LGF shall broadcast a P-value to represent the impact of undetected ephemeris errors on user range error for each ranging source i. The maximum value for P shall be $1.5\text{x}10^{-4}$ m/m. The LGF shall exclude any ranging source for which the P-value cannot be validated.

3.2.1.2.8 Ranging Source Measurement Block

The first ranging source in the message shall sequence so that the ephemeris decorrelation parameter, the ephemeris CRC, and source availability duration for each ranging source is transmitted at least once every 10 seconds, except when new ephemeris data are received from a ranging source. When new ephemeris data are received from a ranging source, the LGF shall broadcast the new ephemeris data for that ranging source in three consecutive Type 1 Messages. When new ephemeris data are received from more than one ranging source, the first ranging source in the Type 1 Message shall sequence so that the ephemeris decorrelation parameter, the ephemeris CRC, and source availability duration for each ranging source are transmitted at least once every 27 seconds.

3.2.1.2.8.1 Ranging Source Identification

The Ranging Source ID Field shall denote the satellite pseudorandom number assigned to the ranging source associated with the ranging source measurement block.

3.2.1.2.8.2 Ranging Signal Sources

The LGF shall be capable of processing:

a. GPS SPS signals, as defined in the GPS SPS Signal Specification and

b. SBAS signals, as defined in the Wide Area Augmentation System (WAAS) Specification (FAA-E-2892B).

3.2.1.2.8.3 Conditions for Transmitting the Ranging Source Measurement Block

The LGF shall cease broadcast of a failed ranging source measurement block within 3 seconds of the onset of the associated ranging source failures, as specified in Sections 3.1.2.1.1 and 3.1.2.1.2.

3.2.1.2.8.3.1 Valid GPS Navigation Data

The LGF shall not broadcast the ranging source measurement block if:

a. Three or more parity errors have been detected in the previous 6 seconds, in accordance with the parity algorithm equations defined in Section 2.5.2 of the GPS SPS Signal Specification,except that parity errors are not counted during the interval when the filter sample interval, as defined in Section 3.2.1.2.8.5.1, exceeds 0.6 seconds;

b. Broadcast Issue of Data (IOD) Ephemeris (IODE) does not match eight least-significant bits of broadcast IOD Clock (IODC);

c. Bit 18 of the Hand-over-Word (HOW) is set to 1 (Section 2.4.2.2 of the GPS SPS Signal Specification);

d. All data bits are zeros in sub-frames 1, 2, or 3;

e. Default navigation data are being transmitted in sub-frames 1, 2, or 3 for that satellite (Section 2.4.1.3 of the GPS SPS Signal Specification);

f. The preamble does not equal 8B (hexadecimal);

g. The same ephemeris and clock data were not used by all RRs to compute the PRC;

h. Any point on the orbit defined by the broadcast ephemeris is more than 7000 m from the orbit defined by the broadcast almanac;

i. After valid corrections were computed by the LGF, the pseudorange correction bound (Section 3.2.1.2.8.5.6.1 [d]) or the RRC bound (Section 3.2.1.2.8.6.1) was exceeded at any time using the broadcast ephemeris data;

j. An SBAS within the reception mask broadcasts a Message Type 2, 3, 4, 5, 6, or 24 indicating "Do Not Use This GPS Satellite" as defined in Section 2.1.1.4 of RTCA/DO-229C, provided that no more than two ranging sources are so designated by SBAS at any one time;

k. The ephemeris CRC changes and the IODE does not;

l. The navigation message that corresponds to GPS PRN is 33, 34, 35, 36, or 37;

m. The health bits in sub-frame 1 word 3 indicate that the satellite is unhealthy.

A new ephemeris shall be compared to the previously broadcast ephemeris, if available, and is validated if the difference in satellite position is less than 250 m and none of the conditions a – m exists. Ephemerides shall be validated and applied within 3 minutes of receiving a new set, but not before they have been continuously present for 2 minutes.

3.2.1.2.8.3.2 Valid SBAS Navigation Data

The LGF shall not broadcast the ranging source measurement block if:

a. Three or more parity errors have been detected in the previous 6 seconds, in accordance with the parity algorithm equations defined in Appendix 2, Section 4.3.3 of FAA-E-2892B, except that parity errors are not counted during the interval when the filter sample interval, as defined in Section 3.2.1.2.8.5.1, exceeds 1.0 second;

b. The same ephemeris and clock data were not used by all RRs to compute the PRC;

c. The satellite position defined by the broadcast ephemeris is more than 200 km from the satellite position defined by the broadcast almanac;

d. The differences between satellite positions defined by any of the SBAS navigation messages broadcast in the previous 4 minutes is greater than 0.12 m;

e. More than 4 minutes have elapsed since reception of the SBAS navigation message;

f. After valid corrections were computed by the LGF, the pseudorange correction bound (Section 3.2.1.2.8.5.6.1 [d]) or the RRC bound (Section 3.2.1.2.8.6.1) was exceeded at any time using the broadcast ephemeris data; or

g. The SBAS satellite, for which the ranging source measurement block provides a correction, broadcasts a Message Type 0 indicating "Do Not Use This SBAS Signal" within the last 60 seconds, a Message Type 2, 3, 4, 5, 6, or 24 indicating "Do Not Use This SBAS Satellite" within the last 6 seconds, or if its Use Range Accuracy (URA) in Message 10 indicate "Unbounded Ranging", as defined in Section 2.1.1.4 of RTCA/DO-229C.

After confirming that none of the conditions a – g exists, new SBAS navigation data shall be used for subsequent measurements.

3.2.1.2.8.4 Issue of Data

The IOD Field shall denote the IODE for GPS or 1111 1111 for SBAS associated with the ephemeris data used to determine the broadcast correction.

3.2.1.2.8.5 Pseudorange Corrections

The Pseudorange Correction Field shall denote the broadcast pseudorange correction.

3.2.1.2.8.5.1 Smoothed Pseudorange

In steady state, each pseudorange measurement from each RR shall be smoothed using the filter

$$PR_s(k) = \left(\frac{1}{N}\right) PR_r(k) + \left(\frac{N-1}{N}\right)\left[PR_s(k-1) + \phi(k) - \phi(k-1)\right] \tag{1}$$

$$N = S/T$$

where PR_r is the raw pseudorange,

PR_s is the smoothed pseudorange,

N is the number of samples,

S is the time filter constant, equal to 100 seconds,

T is the filter sample interval, nominally equal to 0.5 seconds and not to exceed 2 seconds. T shall not exceed 0.5 seconds more than once during every 60-second interval.

ϕ is the accumulated phase measurement,

k is the current measurement, and

k-1 is the previous measurement.

The raw pseudorange shall be determined under the following conditions:

a. The code loop is carrier driven and of first order, or higher, and has a one-sided noise bandwidth ≥ 0.125 Hz.

b. The strongest correlation peak is acquired taking into account the effect of any secondary peak found at any code offset within the entire code sequence.

Note: The requirement for T allows compensation for a momentary loss of signal to ensure continuity for valid ranging sources.

3.2.1.2.8.5.2 GPS Predicted Range

The predicted range to each GPS ranging source shall be computed from the corresponding RR antenna-phase center location and the validated ephemeris. The ephemeris shall be determined in accordance with Section 2.5.4 of the GPS SPS Signal Specification.

3.2.1.2.8.5.3 SBAS Predicted Range

The predicted range to each SBAS ranging source shall be computed from the corresponding RR antenna-phase center location and the validated ephemeris. The position of the ranging source shall be determined in accordance with Appendix 2, Section 4.4.11 of FAA-E-2892B.

3.2.1.2.8.5.4 GPS Smoothed Pseudorange Correction

The smoothed pseudorange correction (PR_{sc}) for a GPS ranging source shall be calculated using the equation

$$PR_{sc} = R - PR_s - t_{sv\_gps} \qquad (2)$$

where R is the predicted range and

t_{sv_gps} is the correction due to the satellite clock from the decoded GPS Navigation Data in accordance with the algorithms given in Sections 2.5.5.1 and 2.5.5.2 of the GPS SPS Signal Specification.

Ionospheric and tropospheric corrections shall not be applied to the smoothed pseudorange correction.

3.2.1.2.8.5.5 SBAS Smoothed Pseudorange Correction

The smoothed pseudorange correction (PR_{sc}) for an SBAS ranging source shall be calculated using the equation

$$PR_{sc} = R - PR_s - t_{sv\_sbas} \qquad (3)$$

where t_{sv_sbas} is the correction due to the satellite clock from the decoded WAAS Navigation Data Message Type 9 in accordance with the algorithm given in Appendix 2, Section 4.4.11 of FAA-E-2892B.

3.2.1.2.8.5.6 Broadcast Correction

The broadcast correction shall be calculated using the equations:

$$PR_{corr}(n) \equiv \frac{1}{M(n)} \sum_{m \in s_n} PR_{sca}(n,m) \text{ and} \qquad (4)$$

$$PR_{sca}(n,m) \equiv PR_{sc}(n,m) - \frac{1}{N_c} \sum_{n \in s_c} PR_{sc}(n,m). \qquad (5)$$

where: PR_{corr} is the broadcast correction;

$M(n)$ is the number of elements in set S_n;

PR_{sca} is the carrier smoothed and receiver clock adjusted pseudorange correction;

n is the satellite index;

S_n is the set of RRs with valid measurements for satellite n;

m is the RR index;

S_c is the set of valid ranging sources tracked by all RRs; and

N_c is the number of elements in set S_c;

given the following conditions:

a. If N_c is less than four, no corrections shall be provided in the Type 1 Message,

b. M shall be at least three for the fault free configuration,

c. Each RR measurement (*m,n*) used to determine the broadcast corrections shall be updated at no less than a 2 Hz rate, and

d. Each RR measurement (*m,n*) used to determine the broadcast corrections shall be based on identical signal processing techniques and tracking loop characteristics.

3.2.1.2.8.5.6.1 Conditions for Broadcast Corrections

The LGF shall broadcast the ranging source measurement block when:

a. σ_{pr_gnd} for the ranging source accounts for the smoothing filter output error relative to steady-state induced by the effect of an ionospheric divergence rate of 0.006 m/s. This rate assumes that a steady-state bias of 1.2 m is induced after 100 seconds, given the code and carrier diverge in opposite directions over that period;

b. The magnitude of the associated B-values does not exceed $\frac{5.6\sigma_{pr\_gnd}}{\sqrt{M(n)-1}}$ (6)

for GPS ranging sources;

c. The magnitude of the associated B-values does not exceed $\frac{5.6\sigma_{pr\_gnd}}{\sqrt{M(n)-1}}$ (7)

for SBAS ranging sources; and

d. The magnitude of the pseudorange correction does not exceed 327.67 m when Selective Availability (SA) is on and 75 m when SA is off.

3.2.1.2.8.6 Range Rate Correction

The Range Rate Correction Field shall indicate the rate of change of the pseudorange correction, defined to be RRC_{corr}, based on the current and immediately prior broadcast corrections. The current and immediately prior broadcast corrections shall compensate for changes in S_c and ephemeris changes to eliminate rate spikes.

3.2.1.2.8.6.1 Condition for Valid Range Rate Correction

The LGF shall not broadcast the ranging source measurement block if:

a. The RRC exceeds ±3.4 m per second when SA is on and ±0.8 m per second when SA is off.

b. The standard deviation of the error in the RRC exceeds 4.0 cm per second.

3.2.1.2.8.6.1.1Range Rate Correction Monitor

The LGF shall not broadcast the ranging source measurement block if

$$B_{RRC} > 5.6\sigma_{rrc}\left(\sqrt{M(n)-1}\right)^{-1} \tag{8}$$

where $B_{RRC}(n,m) = RRC_{corr}(n) - \frac{1}{M(n)-1}\sum_{\substack{i\in S_n \\ i\neq m}} RRC_{sca}(n,i)$, given that (9)

RRC_{sca} is the carrier smoothed and receiver clock adjusted range rate correction for an individual receiver that is compensated for changes in S_c and ephemeris and

σ_{rrc} is the one sigma range rate correction error that is established at installation.

3.2.1.2.8.7 Sigma Pseudorange Ground

The Sigma Pseudorange Ground Field shall denote the sigma bound for each ranging source.

3.2.1.2.8.7.1 GPS Sigma Pseudorange Accuracy

At the minimum signal strength defined in Section 2.3.4 of the GPS SPS Signal Specification and the standard interference environment defined in Appendix A, the accuracy of the LGF shall be such that

$$\sigma_{pr\_gnd}(\theta_n) \leq \sqrt{\frac{\left(a_0 + a_1 e^{-\theta_n/\theta_0}\right)^2}{M} + (a_2)^2} \tag{10}$$

where θ_n is the n[th] ranging source elevation angle,

a_0, a_1, a_2, and θ_0 are the coefficients for the applicable Accuracy Designator defined in Table 3-6, and

M is the number of corrections per ranging source.

Table 3-3. GPS Accuracy Designator C Coefficients

Accuracy Designator C	a_0 meters	a_1 meters	a_2 meters	θ_0 degrees
$\theta_n \geq 35°$	0.15	0.84	0.04	15.5
$\theta_n < 35°$	0.24	0	0.04	-

The accuracy requirement shall be met within the reception mask given in Section 3.2.1.2.6.1. The accuracy requirement shall be met at RR Antenna phase-center heights between 10 and 50 feet.

Note: In cases of dual antennas, the phase-center height of the longer element shall be used.

3.2.1.2.8.7.2 SBAS Sigma Pseudorange Accuracy

At the minimum signal strength defined in Appendix 2, Section 2.6.5 of FAA-E-2892B and the standard interference environment defined in Appendix A, the accuracy of the LGF shall be such that:

$$\sigma_{pr\_gnd} \leq \frac{1.8}{\sqrt{M}} \tag{11}$$

The accuracy requirement shall be met within the reception mask given in Section 3.2.1.2.6.1. The accuracy requirement shall be met at RR Antenna phase-center heights between 10 and 50 feet.

Note: In cases of dual antennas, the phase-center height of the longer element shall be used.

3.2.1.2.8.7.3 Condition for Valid Sigma Pseudorange Ground

The LGF shall detect conditions relating to Sigma Pseudorange Ground, that result in noncompliance with the results in Sections 3.1.2.1 and 3.1.2.2. If the increase in system risk associated with degraded performance is minimal, but exceeds design tolerances, the LGF shall initiate a service alert. The probability of a false service alert shall be adjustable, but set to achieve a nominal false alert rate of $1x\ 10^{-4}$ per hour. If the increase in system risk is not minimal, the LGF shall exclude the offending RR or generate an alarm, as appropriate. A service alert shall be issued when a RR is excluded unless a single RR remains, at which time an alarm shall be issued. Self-recovery shall not be applied in either case. Automatic restart shall not be attempted when an alarm condition exists when system risk is not minimal. The probability of false RR exclusion or alarm shall be less than 1×10^{-7} per 15-second interval.

3.2.1.2.8.7.3.1Sigma Pseudorange Ground Performance Assessment

In detecting the conditions specified in Section 3.2.1.2.8.7.3, the LGF performance shall be computed using the following sets of data: data over one hour and trend of hourly results over one day; data over one day and trend of daily results over one month; data over one month and trend of monthly results over one year, and since initialization. Performance measures shall include mean, sigma, and distribution of B-values per RR. The correlation between RRs shall be assessed with a frequency consistent with the predicted risk associated with a noncompliance condition.

3.2.1.2.8.8 B-Values

The B-Value Field shall denote the B-value calculated using the equation:

$$B_{PR}(n,m) \equiv PR_{corr}(n) - \frac{1}{M(n)-1} \sum_{\substack{i \in S_n \\ i \neq m}} PR_{sca}(n,i) \tag{12}$$

where $B_{PR}(n,m)$ is the estimate of the error contribution from RR m.

3.2.1.3 Type 2 Message – Differential Reference Point

The LGF shall broadcast the Type 2 Message at least once every 20 consecutive frames. The LGF shall broadcast the Type 2 Message a maximum of once per frame. The LGF shall broadcast the Type 2 Message formatted in accordance with Section 2.4.4 of RTCA/DO-246B.

3.2.1.3.1 Ground Station Installed Receivers

The Ground Station Installed Receivers Field shall denote the number of installed reference receivers stored in LGF NVM.

3.2.1.3.2 Ground Station Accuracy Designator

The Ground Station Accuracy Designator Field shall denote the accuracy designator stored in LGF NVM.

3.2.1.3.3 Continuity and Integrity Designator

The LGF Ground Continuity and Integrity Designator (GCID) Field shall denote the LGF GCID. The LGF GCID value shall be 1 when no alarm exists. The LGF GCID value shall be 7 when an alarm exists.

3.2.1.3.4 Local Magnetic Variation

The Local Magnetic Variation Field shall denote the local magnetic variation stored in LGF NVM.

3.2.1.3.5 Sigma Ionosphere

The Sigma Ionosphere Vertical Gradient Field shall denote the sigma ionosphere value stored in LGF NVM.

3.2.1.3.6 Refractivity Index

The Refractivity Index Field shall denote the refractivity index stored in LGF NVM.

3.2.1.3.7 Scale Height

The Scale Height Field shall denote the scale height stored in LGF NVM.

3.2.1.3.8 Refractivity Uncertainty

The Refractivity Uncertainty Field shall denote the refractivity uncertainty stored in LGF NVM.

3.2.1.3.9 Reference Point

The LGF reference point shall be defined as the centroid between all RR antenna locations.

3.2.1.3.9.1 Latitude

The Latitude Field shall denote the LGF reference point latitude stored in LGF NVM.

3.2.1.3.9.2 Longitude

The Longitude Field shall denote the LGF reference point longitude stored in LGF NVM.

3.2.1.3.9.3 Reference Point Height

The Reference Point Height Field shall denote the LGF reference point height above the WGS-84 ellipsoid stored in LGF NVM.

3.2.1.3.10 Reference Station Data Selector (RSDS)

The Reference Station Data Selector field shall denote the LGF RSDS stored in LGF NVM.

3.2.1.3.11 Maximum Use Distance (Dmax)

The Maximum Use Distance field shall denote the LGF Maximum Use Distance stored in LGF NVM. Dmax shall be zero when there is no distance limitation. Dmax shall support a minimum range of 42 km when a distance limitation is required.

3.2.1.3.12 Ephemeris Fault-Free Missed Detection Parameters

3.2.1.3.12.1 $K_{md\_e\_}$ POS, GPS

The $K_{md\_e\_}$ POS, GPS field shall denote the ephemeris fault-free missed detection parameter for the GPS Differential Positioning Service stored in LGF NVM.

3.2.1.3.12.2 $K_{md\_e\_}$ CAT I, GPS

The $K_{md\_e\_}$ CAT I, GPS field shall denote the ephemeris fault-free missed detection parameter for the GPS Category I Precision Approach stored in LGF NVM.

3.2.1.3.12.3 $K_{md\_e\_}$ POS, GLONASS

The $K_{md\_e\_}$ POS, GLONASS field shall denote the ephemeris fault-free missed detection parameter for the GLONASS Differential Positioning Service stored in LGF NVM. This parameter shall be coded as all zeroes.

3.2.1.3.12.4 $K_{md\_e\_}$ CAT I, GLONASS

The $K_{md\_e\_}$ CAT I, GLONASS field shall denote the ephemeris fault-free missed detection parameter for the GLONASS Category I Precision Approach stored in LGF NVM. This parameter shall be coded as all zeroes.

3.2.1.4 Type 4 Message – Final Approach Segment Data

The Type 4 Message shall include the Data Set Length, Final Approach Segment (FAS) Data Block, the FAS/Vertical Alert Limit (VAL) approach status, and the FAS/Lateral Alert Limit (LAL) approach status. The LGF shall broadcast each FAS data block at least once every 20 consecutive frames. The LGF shall broadcast each FAS data block a maximum of once per frame. The LGF shall broadcast the Type 4 Message formatted in accordance with Section 2.4.6 of RTCA/DO-246B.

3.2.1.4.1 Data Set Length

The Data Set Length Field shall denote the Type 4 Message data set length, which indicates the number of bytes in the data set.

3.2.1.4.2 FAS Data Block

The Type 4 Message shall contain the FAS data block for each runway approach served by the LGF. The required content of the data block is defined in the following subsections. This block and its corresponding approach performance designator are broadcast depending on the runway end(s) selected at the ATCU, and the MDT when necessary.

3.2.1.4.2.1 Operation Type

The Operation Type Field shall denote the operation type stored in LGF NVM.

3.2.1.4.2.2 SBAS Provider Identification

The SBAS Provider ID Field shall denote the SBAS service provider ID stored in LGF NVM.

3.2.1.4.2.3 Airport Identification

The Airport Identification Field shall denote the airport identification stored in LGF NVM.

3.2.1.4.2.4 Runway Number

The Runway Number Field shall denote the runway number stored in LGF NVM.

3.2.1.4.2.5 Runway Letter

The Runway Letter Field shall denote the runway letter stored in LGF NVM.

3.2.1.4.2.6 Approach Performance Designator

The Approach Performance Designator Field shall denote the approach category stored in LGF NVM.

3.2.1.4.2.7 Route Indicator

The Route Indicator Field shall denote the route indicator stored in the LGF NVM.

3.2.1.4.2.8 Reference Path Data Selector

The Reference Path Data Selector Field shall denote the reference path data selector stored in LGF NVM.

3.2.1.4.2.9 Reference Path Identifier

The Reference Path Identifier Field shall denote the reference path identifier stored in LGF NVM.

3.2.1.4.2.10 LTP/FTP Latitude

The LTP/FTP Latitude Field shall denote the LTP/FTP latitude stored in LGF NVM.

3.2.1.4.2.11 LTP/FTP Longitude

The LTP/FTP Longitude Field shall denote the LTP/FTP longitude stored in LGF NVM.

3.2.1.4.2.12 LTP/FTP Height

The LTP/FTP Height Field shall denote the LTP/FTP height stored in LGF NVM.

3.2.1.4.2.13 Delta FPAP Latitude

The Δ FPAP Latitude Field shall denote the Δ FPAP latitude stored in LGF NVM.

3.2.1.4.2.14 Delta FPAP Longitude

The Δ FPAP Longitude Field shall denote the Δ FPAP longitude stored in LGF NVM.

3.2.1.4.2.15 Approach Threshold Crossing Height

The Approach Threshold Crossing Height (TCH) Field shall denote the TCH stored in LGF NVM.

3.2.1.4.2.16 Approach TCH Units Selector

The TCH Units Selector Field shall denote the TCH Unit Selector stored in LGF NVM.

3.2.1.4.2.17 Glidepath Angle

The Glidepath Angle (GPA) Field shall denote the GPA stored in LGF NVM.

3.2.1.4.2.18 Course Width

The Course Width Field shall denote the course width stored in LGF NVM.

3.2.1.4.2.19 Delta Length Offset

The Δ Length Offset Field shall denote the Δ length offset stored in LGF NVM.

3.2.1.4.2.20 FAS CRC

The FAS CRC Field shall denote the FAS CRC stored in LGF NVM.

3.2.1.4.3 FAS VAL/Approach Status

The FAS VAL/Approach Status Field shall denote the FAS VAL or “Do Not Use Vertical" stored in LGF NVM. All ones in this field indicate that vertical guidance is not available.

3.2.1.4.4 FAS LAL/Approach Status

The FAS LAL/Approach Status Field shall denote the FAS LAL or “Do Not Use Approach” stored in the NVM. All ones in this field indicate that the approach is not available.

3.2.2 RADIO FREQUENCY TRANSMISSION CHARACTERISTICS

3.2.2.1 Symbol Rate

The symbol rate of the LGF data broadcast shall be 10,500 ±0.005% symbols per second. Each symbol defines one of eight states (3 bits) resulting in a nominal bit rate of 31,500 bits per second.

3.2.2.2 Emission Designator

The FCC emission designator of this modulation technique is 14K0G7DET.

3.2.2.3 Signal Polarization

3.2.2.3.1 Elliptical Polarization (EPOL)

The LGF shall broadcast an elliptically polarized signal.

3.2.2.3.2 Horizontal Polarization (HPOL)

The LGF shall be permitted to broadcast a horizontally polarized signal when an elliptically polarized signal causes unacceptable interference to existing navigation or communication equipment that cannot be mitigated by other means.

3.2.2.4 Field Strength

The Effective Radiated Power (ERP) shall provide a field strength not less than 215 µV/m (-99 dBW/m^2) for a horizontally polarized signal. The ERP shall provide a field strength not greater than 350 mV/m (-35 dBW/ m^2) for a horizontally polarized signal. The ERP shall provide a field strength not less than 136 µV/m (-103 dBW/ m^2) for the vertically polarized signal. The ERP shall provide a field strength not greater than 221 mV/m (-39 dBW/ m^2) for the vertically polarized signal.

3.2.2.4.1 Phase Offset

For elliptically polarized signals, the RF phase offset between the horizontally polarized and vertically polarized signal components shall be such that the minimum signal power defined in Section 3.2.2.4 is achieved throughout the coverage volume for both users of the horizontally polarized signal and users of the vertically polarized signal.

3.2.2.5 Spectral Characteristics

3.2.2.5.1 Carrier Frequencies

The VDB shall use radio frequencies in the band 108 – 117.975 MHz. The lowest selectable channel shall be 108.025 MHz. The highest selectable channel shall be 117.950 MHz. The separation between selectable frequencies shall be 25 kHz.

3.2.2.5.2 Unwanted Emissions

Unwanted emissions, including spurious and out-of-band emissions, shall be compliant with the levels shown in Table 3-4. The total power in any VDB harmonic or discrete signal shall be no greater than -53 dBm.

Table 3-4. Unwanted Emission Levels

Frequency	Relative Unwanted Emission Level [2]	Maximum Unwanted Emission Level [1]

9 kHz to 150 kHz	-93 dBc	-55 dBm/1kHz [3]
150 kHz to 30 MHz	-103 dBc	-55 dBm/10 kHz [3]
30 MHz to 106.125 MHz	-115 dBc	-57 dBm/100 kHz
106.425	-113 dBc	-55 dBm/100 kHz
107.225	-105 dBc	-47 dBm/100 kHz
107.625	-101.5 dBc	-53.5 dBm/10 kHz
107.825	-88.5 dBc	-40.5 dBm/10 kHz
107.925	-74 dBc	-36 dBm/1 kHz
107.975	-65 dBc	-27 dBm/1 kHz
118.000	-65 dBc	-27 dBm/1 kHz
118.050	-74 dBc	-36 dBm/1 kHz
118.150	-88.5 dBc	-40.5 dBm/10 kHz
118.350	-101.5 dBc	-53.5 dBm/10 kHz
118.750	-105 dBc	-47 dBm/100 kHz
119.550	-113 dBc	-55 dBm/100 kHz
119.850 to 1 GHz	-115 dBc	-57 dBm/100 kHz
1 GHz to 1.7 GHz	-115 dBc	-47 dBm/1MHz

Note 1. The maximum unwanted emission level (absolute power) applies if the authorized transmitter power exceeds 150 W.

Note 2. The relative unwanted emission level is to be computed using the same bandwidth for desired and unwanted signals. This may require conversion of the measurement for unwanted signals done using the bandwidth indicated in the maximum unwanted emission level column of Table 3-4.

Note 3. This value is driven by measurement limitations. Actual performance is expected to be better.

Note 4. The relationship is linear between single adjacent points designated by the adjacent channels identified in Table 3-4.

3.2.2.6 Adjacent Channel Emissions

The amount of power during transmission under all operating conditions when measured over a 25 kHz bandwidth centered on any adjacent channel shall not exceed the values given in Table 3-5:

Table 3-5. Adjacent Channel Emissions

Channel	Relative Power	Maximum Power
1st Adjacent	-40 dBc	12 dBm
2nd Adjacent	-65 dBc	-13 dBm
4st Adjacent	-74 dBc	-22 dBm
8st Adjacent	-88.5 dBc	-36.5 dBm
16st Adjacent	-101.5 dBc	-49.5 dBm
32st Adjacent	-105 dBc	-53 dBm
64st Adjacent	-113 dBc	-61 dBm
76st Adjacent and beyond	-115 dBc	-63 dBm

Note 1. The maximum power applies if the authorized transmitter power exceeds 150 W.

Note 2. The relationship is linear between single adjacent points designated by the adjacent channels identified in Table 3-5.

3.2.2.6.1 Adjacent Temporal Interference

Under all operating conditions, the maximum power over a 25 kHz bandwidth, centered on the assigned frequency, when measured over any unassigned time slot, shall not exceed -105 dBc referenced to the authorized transmitter power.

3.2.2.6.2 Frequency Stability

The long-term stability of the transmitter carrier frequency shall be ± 0.0002%.

3.2.2.7 Modulation

Binary data shall be assembled into symbols, each consisting of three consecutive bits. The end of the data shall be padded by up to two fill bits if necessary to form the last 3-bit symbol of the burst. Symbols shall be converted to differentially encoded 8-phase shift keyed (D8PSK) carrier phase shifts ($\Delta\phi_k$) as shown in Table 3-6.

The carrier phase for the k^{th} symbol (ϕ_k) is given by

$$\phi_k = \phi_{k-1} + \Delta\phi_k. \tag{13}$$

The transmitted signal shall be

$$H(e^{j(2\pi ft + \phi(t))}) \tag{14}$$

where H(•) is a raised cosine filter with α=0.6 as defined in Section 3.2.2.7.1.

Table 3-6. Data Encoding

Message Bits (note)			**Symbol Phase Shift**
$\mathbf{I_{3k-2}}$	$\mathbf{I_{3k-1}}$	$\mathbf{I_{3k}}$	$\Delta\phi_k$
0	0	0	0
0	0	1	$1\pi/4$
0	1	1	$2\pi/4$
0	1	0	$3\pi/4$
1	1	0	$4\pi/4$
1	1	1	$5\pi/4$
1	0	1	$6\pi/4$
1	0	0	$7\pi/4$

Note: I_j is the j^{th} bit of the burst to be transmitted, where I_1 is the first bit of the training sequence. The values of $\Delta\phi_k$ represent counter clockwise rotations in the complex I-Q plane of Figure 2-1 of RTCA/DO-246B.

3.2.2.7.1 Pulse Shaping Filters

The output of differential phase encoder shall be filtered by a pulse shaping filter whose output, s(t), is

$$s(t) = \sum_{k=-\infty}^{k=\infty} e^{j\phi_k} h(t - kT) \tag{15}$$

where h = the impulse response of the raised cosine filter

t = time

T = duration of each symbol (T=1/10500 second, approximately 95.2 µsec) and

ϕ_k = as defined in Section 3.2.2.7.

This pulse shaping filter shall have a nominal complex frequency response of a raised-cosine filter with $\alpha = 0.6$. The frequency response, *H(f),* and the time response, *h(t),* of the base band filters shall be in accordance with

$$H(f) = \begin{cases} 1 & 0 < f < \dfrac{1-\alpha}{2T} \\ \dfrac{1-\sin\left(\dfrac{\pi}{2\alpha}(2fT-1)\right)}{2}, & \dfrac{1-\alpha}{2T} \leq f \leq \dfrac{1+\alpha}{2T} \\ 0 & f > \dfrac{1+\alpha}{2T} \end{cases} \tag{16}$$

$$h(t) = \frac{\sin\left(\dfrac{\pi t}{T}\right)\cos\dfrac{\pi\alpha t}{T}}{\dfrac{\pi t}{T}\left[1-\left(\dfrac{2\alpha t}{T}\right)^2\right]} \tag{17}$$

where f is the absolute value of the frequency offset from the channel center,

T is the symbol period of 1/10500 seconds (approximately 95.2 μ seconds),

t is time, and

α is 0.6.

3.2.2.7.2 Error Vector Magnitude

The error vector magnitude of the transmitted signal shall be less than 6.5% RMS.

3.2.2.8 Burst Data Content

Burst Data Content shall comply with Section 2.3 of RTCA/DO-246B.

3.2.2.9 Broadcast Timing Structure Division Multiple Access

The broadcast timing structure shall comply with Section 2.2 of RTCA/DO-246B. The LGF shall be capable of transmitting in any two of eight time slots within each frame. The LGF shall be capable of broadcasting in a minimum of two slots per frame per VDB antenna. In every frame, the LGF shall broadcast a message in every slot designated in LGF NVM.

3.2.3 RADIO FREQUENCY BROADCAST MONITORING

The data broadcast transmissions shall be monitored. The transmission of the data shall cease within 0.5 seconds when any of the following conditions exist:

a. Continuous disagreement for any 3 second period between the transmitted application data and the application data derived or stored by the monitoring system prior to transmission,

b. A transmitted power offset of more than 3 dB from the on-channel assigned power for 3 seconds,

c. More than 0.2% of messages in the last hour are not transmitted,

d. No transmission for 3 seconds, or

e. Any transmitted data outside of the assigned TDMA time slots for 3 seconds.

Conditions 'a' – 'e' include the time to switch to redundant equipment, if available.

3.3 OPERATION AND MAINTENANCE

Operations and maintenance functions are provided via internal and external LGF components. These components include:

a. LSP (internal)

b. MDT (external)

c. RSP (external)

d. ATCU (external)

e. LGF Built-in-Test (BIT) (internal)

f. Recording (internal, Sections 3.3.3.1 and 3.3.3.2)

g. Recording (external, Sections 3.3.3.3 and 3.3.3.4)

Figure 3-4 provides a high-level diagram depicting the functional relationship between the LGF and Operations and Maintenance.

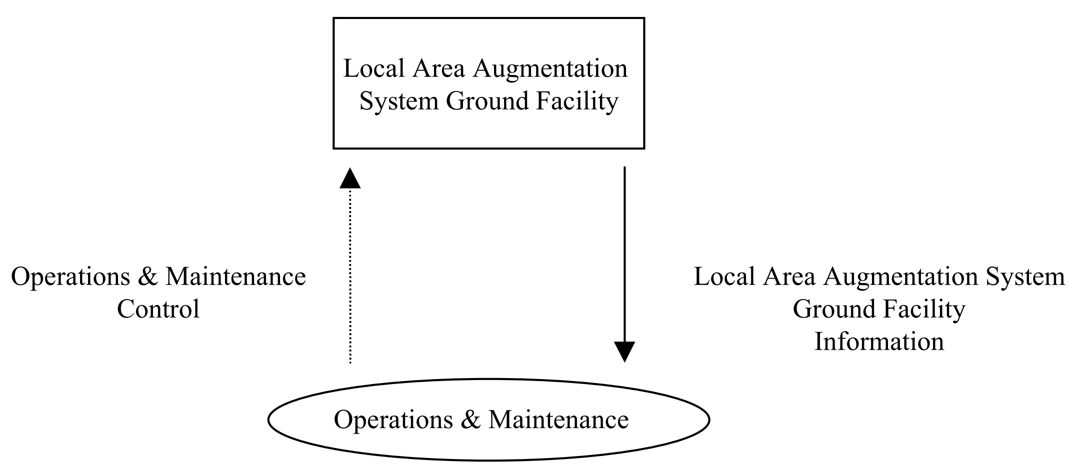

Figure 3-4. Operations and Maintenance

The internal and external interfaces of the LGF are depicted in Figure 3-5.

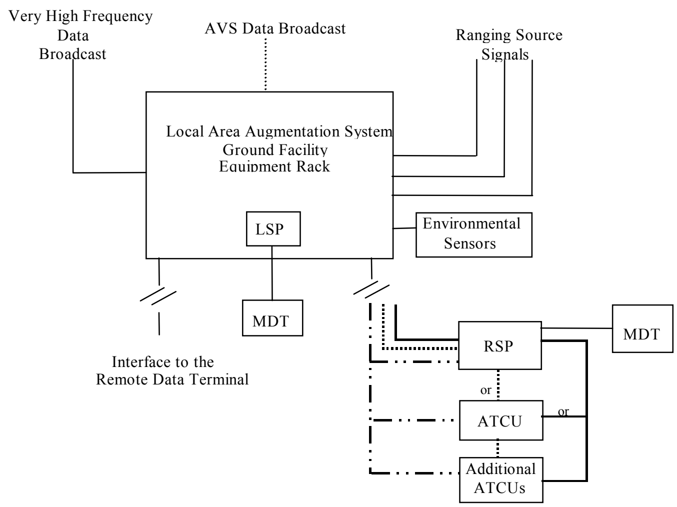

Figure 3-5. Local Area Augmentation System Ground Facility Interfaces

3.3.1 SYSTEM REQUIREMENTS

3.3.1.1 LGF Configurations

3.3.1.1.1 LGF Standard Equipment Configuration

The LGF shall be configured such that:

a. There are at least four (4) RR/RR-antenna pairs.

b. The RR/RR-antenna pairs are collocated.

c. The primary VDB electronic equipment, including transmitter, monitor, and power amplifier, are fully redundant; and, both sets of equipment are housed in the primary equipment shelter.

d. The VDB equipment shares a common antenna.

e. The LGF corrections processors, integrity monitor processors, power supplies, back-up power source, and LSP are housed in the primary equipment shelter.

f. Equipment fits in standard 19 in. racks in a standard equipment shelter not to exceed 10 ft. by 16 ft. by 8 ft.

g. There are a minimum of two (2) ATCUs.

3.3.1.1.2 LGF Subsystem Installation Requirements

3.3.1.1.2.1 Reference Receiver/Primary Equipment Shelter

The RR shall be able to be located at a lateral distance up to 5 nmi from the primary equipment shelter.

3.3.1.1.2.2 Primary VDB Antenna/Primary Equipment Shelter

The primary VDB antenna and the primary equipment shelter shall be connected via an RF interface. The LGF shall utilize a single VDB and RF Interface to provide the defined coverage, as specified in Section 3.1.1.1 to a minimum of one (1) runway end. VDB antenna height shall be variable from 15 ft. to a maximum of 70 ft.

3.3.1.1.2.3 Additional VDB Subsystem (AVS)/Primary Equipment Shelter

The AVS shall be located at a lateral distance up to 5 nmi from the primary equipment shelter. The LGF shall include a minimum of two (2) AVS interfaces.

3.3.1.1.2.4 Secondary Equipment Shelter(s)

The secondary equipment shelter(s) shall be located at a lateral distance up to 5 nmi from the primary equipment shelter. Equipment shall fit in standard 19 in. equipment racks, in a standard size shelter not to exceed 10 ft. by 16 ft. by 8 ft.

3.3.1.1.3 LGF Enhanced Configuration Options

3.3.1.1.3.1 Additional VDB Subsystem

The LGF shall have an interface to support two Additional VDB Subsystems (AVS). The AVS VDB antenna and VDB electronic equipment shall be identical to the Primary VDB Subsystem hardware. Each AVS shall have a dedicated equipment shelter that will house AVS electronics. Each AVS shall be able to operate concurrently with the Primary VDB Subsystem. Each AVS shall be able to operate independently of the Primary VDB Subsystem; each AVS shall operate if the primary VDB electronic equipment is removed or non-functional. All VDB antennas shall provide coverage to a minimum of one (1) runway end. VDB antenna height shall be variable from 15 ft. to a maximum of 70 ft.

3.3.1.1.3.2 High Availability Configuration

The high availability configuration shall include redundant equipment as necessary to meet the availability specified in 3.3.1.8.2.2 . This configuration shall be provided with the redundant equipment located in a secondary equipment shelter. The redundant equipment shall be able to operate when the VDB in the primary shelter is non-functional. The redundant equipment shall be able to operate when the standard equipment configuration is non-functional.

Note 1: The standard configuration, each AVS, and the redundant equipment for the high availability configuration may provide overlapping coverage, with the exception that each VDB antenna provide approach coverage to a minimum of one (1) runway. This allows for the AVS and/or the high availability subsystem to provide for both enhanced availability and antenna diversity.

Note 2: Inherent Availability, as defined, does not imply that all runways have service availability, but is intended to guarantee service to a given runway or runways supported by the VDB antennas particular to the configuration.

3.3.1.2 Computer Resource Reserve Capacity

3.3.1.2.1 Computer Memory

The LGF shall incorporate error sensing, error reporting, and error correction to all memory processors and component hardware.

3.3.1.2.2 Volatile Memory

At delivery, no more than 50% of the total addressable, populated memory locations per processor shall be used during execution of any program to hold instructions or data.

3.3.1.2.3 Processing Speed

At delivery, each processor, including input/output subsystems, in the LGF System that executes software in support of system performance requirements shall use a maximum of 70% of the processor's throughput capability.

3.3.1.3 Environmental Design Values

Environmental design values for the LGF shall comply with the environmental conditions of Table 3-7.

3.3.1.3.1 Environmental Service Conditions

LGF equipment designed for use in attended facilities shall operate in the ambient conditions of Environment I in Table 3-7. LGF equipment designed for use in unmanned facilities shall comply with the ambient conditions of Environment II listed in Table 3-7. LGF equipment not housed in shelters shall operate in the ambient conditions of Environment III listed in Table 3-7.

Table 3-7. Environmental Conditions

Environment[1]	Temperature (°C)	Relative Humidity[3] (%)	Altitude (ft above sea level)	Wind (mph)	Ice Loading	Rain
I	+10 to +50	10 to 80	0 to 10,000	--	--	--
II	0 to +50	5 to 90	0 to 10,000	--	--	--
III[4]	-50 to +70[2]	5 to 100	0 to 10,000	0 to 100	Encased in	2" /

					½"radial thickness clear ice	hour

1. I: For equipment installed in an attended facility.
II: For equipment installed in an unattended facility.
III: For equipment installed outdoors (antennas, field detectors)
2. Includes 18°C for solar radiation.
3. Above 40°C, the relative humidity shall be based upon a dew point of 40°C.
4. Conformal coating is required only when equipment is exposed to salt atmosphere or located in tropical climates.

3.3.1.3.2 Wind and Ice Loading

Wind and ice loading values for LGF externally exposed equipment shall comply with Section 3.2.1.2.3 of FAA-G-2100F.

3.3.1.3.3 VDB and Reference Receiver Antenna Frangibility

VDB and Reference Receiver antenna support masts shall include a frangible coupling with the following requirements:

a. Each break-away mechanism of the structure shall be designed and constructed to absorb no more than 700 foot pounds of impact energy.

b. If any member exceeds four (4) feet in length, additional break-away joints shall be provided.

c. The maximum spacing of the break-away mechanisms shall be four (4) feet.

d. To achieve maximum frangibility, the break-away mechanisms shall be applicable to all members regardless of their geometric orientation.

e. The electronic equipment and components shall be designed and constructed with break-away mechanisms, provided that the operational functions are not degraded.

f. "Quick-disconnect" connectors shall be installed in the vertical runs of the electrical conductors in order to facilitate the break-apart action of the electrical conductor and insulation during the impact phenomena.

g. The "quick-disconnect" connector shall be placed so that they are spaced adjacent to the break-away mechanism.

3.3.1.3.4 Non-Operating Conditions

Shipped, stored, and transported equipment for the LGF shall comply with Section 3.2.1.2.4 of FAA-G-2100F.

3.3.1.3.5 Corrosion Resistance

Metals shall be corrosion resistant or coated to resist corrosion in compliance with Section 3.3.1.1.3 of FAA-G-2100F.

3.3.1.3.5.1 Corrosion-Resisting Ferrous Alloys

Austenitic corrosion-resistant steel shall be used for all structural parts that will be subjected to severe corrosive conditions in compliance with Section 3.3.1.1.3.1 of FAA-G-2100F.

3.3.1.3.5.2 Iron and Steel

Iron and steel shall be used only when necessary to comply with strength requirements in accordance with Section 3.3.1.1.3.2 of FAA-G-2100F. In the instances when iron or steel is used, such materials shall be treated to prevent corrosion in compliance with Section 3.3.1.1.3.2 of FAA-G-2100F.

3.3.1.4 Primary Power

The LGF shall operate from a nominal 120 volt, 60 Hz, three wire, single-phase AC power source.

3.3.1.5 Supplementary Power

The LGF shall include an uninterruptible supplementary power source. The supplementary power source shall continuously power the LGF for a period of not less than four hours after a loss of primary power under nominal conditions. Nominal conditions are defined to be a room temperature of 30° C and a Voltage Standing Wave Ratio (VSWR) of 1.5:1.

3.3.1.5.1 Power Supply

The LGF shall automatically sense when the supplementary power discharge point is reached. When operating on supplementary power, the LGF shall initiate facility shutdown if a critical discharge point is met. Upon restoration of primary power, the LGF shall self-restore to operate on primary power. To maintain the supplementary power in operational readiness, a trickle charge shall be supplied to recharge the supplementary power during the period of available primary power. Upon loss and subsequent restoration of primary power, the LGF supplementary power shall restore to a full charge condition from a 50% discharge condition within 8 hours. The LGF shall continue at the same level of service upon restoration of primary power.

3.3.1.6 Environmental Sensors

The LGF design shall include an:

a. Intrusion detector sensor,

b. Smoke detector sensor,

c. Obstruction lights sensor,

d. Ac power sensor,

e. Inside temperature sensor, and

f. Outside temperature sensor.

The environmental sensor output shall be processed by the LGF and retrievable by the MDT. The LGF shall be capable of bypassing any sensor that is not utilized.

3.3.1.6.1 Intrusion Detector

The intrusion detector shall detect when the LGF shelter door has been open for any period greater than 0.50 seconds. The LGF shall generate a service alert message if valid log-on ID and password entries are not received within 5 minutes of detecting an open shelter door. Upon command, the LGF shall arm and bypass the intrusion detector through the MDT.

3.3.1.6.2 Smoke Detector

The smoke detector shall be an ionization-type smoke detector. The smoke detector shall meet the requirements of Underwriters Laboratories (UL), Inc. Standard 268. The smoke detector shall bear the UL, Inc. label. The LGF shall generate a service alert upon detection of combustion products.

3.3.1.6.3 Obstruction Lights

The LGF shall identify when a lamp has failed in the obstruction light assembly of the antennas. The LGF shall generate an alert message when a lamp fails.

3.3.1.6.4 AC Power

The AC power sensor shall detect the presence of primary AC power. The AC power sensor shall detect the absence of acceptable primary AC power. The LGF shall generate a service alert when a loss of AC power is detected.

3.3.1.6.5 Inside Temperature

The inside temperature sensor shall provide the temperature inside the LGF equipment shelter to the LGF, with a minimum resolution of one-degree centigrade. The accuracy over the range of -10º to +50º centigrade shall be ± 5º centigrade without calibration. The LGF shall generate an alert when the temperature has exceeded the alert thresholds. The LGF shall generate a service alert message when the upper and lower temperature design thresholds are exceeded.

3.3.1.6.6 Outside Temperature

The outside temperature sensor shall provide the temperature outside the LGF equipment shelter to the LGF with a minimum resolution of no less than one-degree centigrade. The accuracy over the range of -50° to +70° centigrade shall be ± 5° centigrade without calibration.

3.3.1.7 Fault Diagnostics, Built-in-Test, and Isolation Procedures

Upon command, the LGF shall perform automatic and manually initiated fault diagnosis to the LRU level. The resulting data shall be stored in memory until manually cleared via the MDT. Stored data shall be accessible via the MDT. Manually initiated diagnostics shall be available from the MDT. A combination of fault diagnostics, BIT, and manual isolation shall enable the following:

a. Automatically initiating the diagnostic routine when an alarm occurs,

b. Automatic diagnostic fault isolation rates at 90% or greater to an ambiguity group of three LRUs or less, and

c. Manual isolation to a single LRU 100% of the time.

3.3.1.8 Maintainability of Electronic Equipment

3.3.1.8.1 Maintenance Concept

The LGF shall provide for a site and depot concept of maintenance. This concept assumes the use of modular equipment that enables maintenance specialists to correct a majority of equipment failures on-site by replacing the faulty LRU.

3.3.1.8.2 Availability

3.3.1.8.2.1 Standard Equipment Configuration

The standard equipment configuration shall have a mean time between critical failures (MTBCF) of at least 5,000 hours and an inherent availability, A_I, of 0.9999. A critical failure shall be defined as any failure resulting in an alarm condition as defined in Section 3.1.5.1.5. This assumes an ideal support environment, with the MTTR as specified in 3.3.1.8.4.1 and the MTBF as specified in 3.3.1.8.3.

3.3.1.8.2.2 High Availability Configuration

The high availability configuration shall have an MTBCF of at least 50,000 hours and an inherent availability, A_I, of 0.99999.

3.3.1.8.3 Reliability

The Mean Time Between Failures (MTBF) for the standard configuration shall be at least 2190 hours. The MTBF for the High Availability Configuration Secondary Equipment Shelter shall be 2190 hours. A failure shall be defined as any failure resulting in an alarm as defined in Section 3.1.5.1.5, or a service alert as defined in Section 3.1.5.1.3.

3.3.1.8.4 Maintainability

3.3.1.8.4.1 Mean Time To Repair (MTTR)

The Mean-Time-to-Repair (MTTR) shall be less than 30 minutes. The repair time shall include:

a. Diagnostic time,

b. Removal of the failed LRU,

c. Installation of the new LRU,

d. Initialization of the new LRU, and

e. All adjustments required to return the LGF to Normal Mode.

Any replacement of a failed LRU that does not require a re-certifying flight check may be completed while the LGF is in Normal Mode.

3.3.1.8.4.2 Periodic Maintenance

Periodic maintenance for the LGF shall not interrupt service for more than eight hours per year of operation. No single group of periodic procedures shall be required more frequently than every 2190 hours. Periodic maintenance for the RSP shall not exceed one hour in 4380 hours of operation. Periodic maintenance for the ATCU shall not exceed one hour in 4380 hours of operation. Periodic maintenance shall include the time required to complete the routine checks and inspections necessary to assure normal operation.

Upon command, the MDT shall isolate latent faults affecting integrity and continuity utilizing embedded equipment, software, or special test equipment.

3.3.1.8.5 System Specialist Workload

Completion of corrective and periodic maintenance actions shall require no more than two system specialists.

3.3.1.9 Security

The internal and external LGF components shall protect internally stored information and information transfer in accordance with FAA Order 1600.69 and FAA Order 1370.82.

3.3.1.9.1 System Identifiers and Authenticators

The internal and external components of the LGF shall restrict access via log-on implementation. Security authentication shall ensure only authorized personnel can log-on successfully. LGF displays shall display a warning banner approved by the Office of the Chief Information Officer (CIO) and the Officer of the Chief Counsel (AGC) to each user before login.

3.3.1.9.1.1 Security Levels

All information pertaining to the LGF shall be assigned a minimum-security level in accordance with FAA Order 1370.82.

3.3.1.9.1.2 Read Access

Upon command, the RSP and LSP interface, via an MDT, shall read LGF internally stored data and diagnostic information . The RMDT port shall have read access.

3.3.1.9.1.3 Write Access

Upon command, the LSP and RSP with an MDT shall load FAS data, input site-specific parameters, and all other maintenance actions in accordance with Sections 3.3.1.9.1.3.1 and 3.3.1.9.1.3.2.

3.3.1.9.1.3.1 Write Access – LSP

The LSP shall have write access while in Test Mode, Normal Mode, and Not Available Mode.

3.3.1.9.1.3.2 Write Access – RSP

The RSP shall have write access while in Normal Mode and Not Available Mode.

3.3.1.9.2 User Identifications and Passwords

3.3.1.9.2.1 Password Distribution

The distribution of User IDs and initial password assignment shall be available only to the System Administrator (Access Level 3 as defined in 3.3.1.9.2.4). Passwords shall be stored in a protected file and in an encrypted format. Password file shall be alterable only by the secure portion of the operating system through System Administrator commands.

3.3.1.9.2.2 Characteristics of Passwords and User Identifications

User IDs and passwords for the LGF shall contain a minimum combination of six alphanumeric characters and a maximum combination of eight alphanumeric characters. Passwords shall include at least one numeric or special character, neither of which may occur as the first or last character of the password. Acceptable special characters are: @, #, $, and &. The LGF shall accommodate 24 user ID and password combinations.

3.3.1.9.2.3 Changing Passwords and User Identifications

The ability to add, delete, and modify user IDs and passwords shall be preceded by a password confirmation prompt. User IDs shall be visible to the log-on terminal. User ID and password lists shall be immediately and automatically updated to reflect changes entered at an MDT. Users shall be prompted to change passwords upon first use. Users shall be prompted by the system to change passwords every 90 days after first use, reconfigurable up to 365 days by a System Adminstrator. Passwords shall not be reused for a period of 3 years.

3.3.1.9.2.4 Logical Access Control

Logical access to files and objects shall be restricted via password and user ID combinations. Logical access levels shall include the following:

a. Access Level 1: Read Only – General Use

b. Access Level 2: Read/Write – Certified Maintenance Specialist

c. Access Level 3: Administrative – Full Access

3.3.1.9.3 Invalid User Identification or Password Entry

An invalid logon entry attempt shall cause:

a. An error message indicating "Invalid User ID or Password" to be output to the MDT,

b. The access procedure to be terminated after three consecutive logon attempts,

c. The LGF logon process to return to idle, and

d. Denial of user access for a period of 15 minutes after three invalid entries.

The system shall allow up to three failed logon attempts before User ID is suspended.

3.3.1.9.4 Log-on Time-out

The LGF shall have a time-out that requires repeating the log-on procedure if the interface is idle for more than 15 minutes. Any valid message transmitted over the interface shall re-initiate the timeout.

3.3.1.9.5 Accountability and Audit Trails

The system shall have for an audit log file as part of the system events recording function (3.3.3.1). The log file shall be alterable only by the secure portion of the operating system. All system administration functions and security-relevant activities performed by a user, both successful and unsuccessful, shall be logged in the audit log file. All successful and unsuccessful logon attempts shall be recorded in the audit log file. The system shall include applications to review the audit log file.

3.3.1.10 Physical Design and Packaging

The LGF and the status and control subsystem-component equipment shall facilitate the accomplishment of all testing, adjustments, and maintenance procedures through physical design and packaging.

3.3.1.11 Electrical

3.3.1.11.1 Electrical Wiring

Electrical wiring shall comply with Section 3.1.2.1 of FAA-G-2100F.

3.3.1.11.1.1 External Wiring

External wiring to equipment that interfaces with the power source shall be in accordance with the National Electrical Code (NFPA 70), FAA-STD-032, and FAA-C-1217.

3.3.1.11.2 Alternating Current Line Controls

Each control switch, relay, circuit breaker, fuse, or other device that acts to disconnect the AC supply line energizing the LGF equipment shall be in accordance with NFPA 70 or UL 1950 for Information Technology Equipment.

3.3.1.11.3 Main Power Switch

The LGF shall have a front panel-mounted main power switch(es) labeled “On/Off”. No more than two main power switches shall be allowed per equipment rack. The LGF shall protect the main power so that it is not cut-off involuntarily. Main power termination shall include supplementary power termination. Switches or circuit breakers that function as main power switches shall comply with Section 3.1.2.2.2 of FAA-G-2100F.

Note: Power down sequences shall be published in an Operator’s Manual and made accessible to operators.

3.3.1.11.4 AC Line-Input Resistance to Ground

Each individual chassis unit connected to the AC supply line shall comply with Section 3.1.2.2.3 of FAA-G-2100F.

3.3.1.11.5 AC Line Connectors and Power Cord

Plugs, receptacles, and power cords to connect the equipment to the AC supply line shall meet the requirements of NFPA 70 and be in accordance with Section 3.1.2.2.4 of FAA-G-2100F.

3.3.1.11.6 AC Line Controls

Each equipment unit energized by direct connection to the AC line shall comply with Section 3.1.2.2.5 of FAA-G-2100F.

3.3.1.11.7 Transformer Isolation, Direct Current Power Supplies

All non-switching Direct Current (DC) power supplies energized from the AC line power source shall be in accordance with Section 3.1.2.2.6 of FAA-G-2100F.

3.3.1.11.8 Voltage Regulators

External voltage regulating transformers shall not be used. Voltage or current regulators, or both, in the DC output circuit of the power supplies, shall provide voltage regulation in the equipment.

3.3.1.11.9 Convenience Outlets

Convenience outlets on the equipment cabinets shall be in accordance with Section 3.1.2.2.7 of FAA-G-2100F.

Note: Only the minimum number of convenience outlets necessary for maintenance should be provided.

3.3.1.11.10 Circuit Protection

All equipment power-output circuits shall include circuit protection in accordance with Section 3.1.2.3 of FAA-G-2100F.

3.3.1.11.11 Electrical Overload Protection

3.3.1.11.11.1 Current Overload Protection

Current overload protection for equipment shall be in accordance with Section 3.1.2.4.4.1 of FAA-G-2100F.

3.3.1.11.11.2 Protective Devices

Protective devices for wired-in equipment shall be in accordance with Section 3.1.2.4.4.2 of FAA-G-2100F.

3.3.1.11.12 Circuit Breakers

Circuit breakers shall be in accordance with Section 3.1.2.4.4.3 of FAA-G-2100F.

3.3.1.11.12.1 Short Circuit Coordination

Short circuit coordination shall comply with Section 3.1.2.4.4.3.1 of FAA-G-2100F.

3.3.1.11.12.2 Normal Performance

The use of overload or other protective devices shall comply with Section 3.1.2.4.4.4 of FAA-G-2100F.

3.3.1.11.13 Test Points and Test Equipment

Functional checks and trouble shooting of the LGF shall be possible through the provision of test points that are readily accessible.

3.3.1.11.13.1 Built-in-Test Device Requirements

BIT devices shall comply with Section 3.1.2.5.1 of FAA-G-2100F.

3.3.1.11.13.2 Location of Test Points and Adjustment Controls

Location of test points and adjustment controls shall comply with Section 3.1.2.5.3 of FAA-G-2100F.

3.3.1.11.13.3 Test Point Circuitry Protection

Test point circuitry protection shall comply with Section 3.1.2.5.4 of FAA-G-2100F.

3.3.1.11.13.4 Failure

BIT devices shall comply with Section 3.1.2.5.5 of FAA-G-2100F.

3.3.1.11.14 Electrical Breakdown Prevention

Preventative measures for electrical breakdown shall be in accordance with Section 3.1.2.6.2 of FAA-G-2100F.

3.3.1.11.15 Grounding, Bonding, Shielding, and Transient Protection

Grounding, bonding, shielding, and transient protection for the LGF shall be in accordance with FAA-STD-020 for Non-Developmental Items (NDI) and developmental items. At the facility interface, the requirements for grounding, bonding, shielding, and transient protection shall be in accordance with NFPA 70 and shall not violate the requirements of FAA-STD-020. If the item is to be UL-recognized, protective measure shall be in accordance with UL 1950 for Information Technology Equipment.

3.3.1.11.16 Obstruction Lights

A double obstruction light assembly shall be provided, where required, in accordance with FAA AC 150/5345-43E and FAA AC 70/7460-1J. The lamps shall be wired in parallel. The lamps shall be rated at 100 watts each.

3.3.1.11.17 Power Factor

The power factor shall comply with the requirements in Section 9.J(4) of FAA Order 6950.2D.

3.3.1.11.18 Peak Inrush Current

Peak inrush current and total current harmonic distortion shall meet the requirements of Section 3.1.2.4.3 of FAA-G-2100F and Sections 9.J(3) and 9.J(5) for FAA Order 6950.2D.

3.3.1.12 Markings

Markings shall be permanent and legible. Markings and labels shall meet the requirements of the FAA Human Factors Design Guide, Section 6.3.5.

3.3.1.12.1 Radio Frequency Connectors

Markings for RF connectors shall comply with Section 3.3.3.2.2.1 of FAA-G-2100F.

3.3.1.12.2 Fuse Markings

Markings for fuse positions shall comply with Section 3.3.3.2.2.4 of FAA-G-2100F.

3.3.1.12.3 Terminal Strips and Blocks

Markings for terminal strips and blocks shall comply with Section 3.3.3.2.2.5 of FAA-G-2100F.

3.3.1.12.4 Controls and Indicating Devices

Markings for controls and indicating devices shall comply with Section 3.3.3.2.2.7 of FAA-G-2100F.

3.3.1.12.5 Nameplates

Furnished equipment shall have one or more nameplates as determined by the equipment configuration in accordance with Figure IV of FAA-G-2100F.

3.3.1.12.6 Safety Related Markings

Guards, barriers or access doors, covers, and plates shall be marked to indicate the hazard that may be reached upon removal of such devices. When possible, marking shall be located such that it is not removed when the barrier or access door is removed. Warnings of hazards internal to a unit shall be marked adjacent to hazards if they are significantly different from those of surrounding items. Such a case would be a high voltage terminal in a group of low voltage devices. Safety Related Markings shall meet FAA Human Factors Design Guide, Section 6.3.5.1.2 and Section 12.16.

3.3.1.12.6.1 Physical Hazards

Physical hazards shall be marked with color codes in accordance with American National Standards Institute (ANSI) Z535.l where applicable to electronic equipment.

3.3.1.12.6.2 Center-of-Gravity

Center-of-Gravity shall be marked on all equipment with a center-of-gravity 50% different from the Center-of-Volume of the chassis. If equipment is to be lifted or carried by more than one person, the label shall include the number of people recommended to lift or carry it, as required by FAA Human Factors Design Guide, Section 6.2.2.10.

3.3.1.12.7 Accident Prevention Signs and Labels

Accident prevention signs and labels shall be in accordance with Section 3.3.6.5.2 of FAA-G-2100F.

3.3.1.12.8 Sign Design

Sign design shall be in accordance with Section 3.3.6.5.2.1 of FAA-G-2100F.

3.3.1.12.9 Sign Classification and Detailed Design

3.3.1.12.9.1 Class I - Danger Classification

Signs indicating immediate and grave danger or peril, a hazard capable of producing irreversible damage or injury, and prohibitions against harmful activities shall be in accordance with Section 3.3.6.5.2.2.1 of FAA-G-2100F.

3.3.1.12.9.2 Class II - Caution Classification

Signs used to call attention to potential danger or hazard, or a hazard capable of or resulting in severe, but not irreversible injury or damage, shall be in accordance with Section 3.3.6.5.2.2.2 of FAA-G-2100F.

3.3.1.12.9.3 Class III - General Safety Classification

Signs of general practice and rules relating to health, first aid, housekeeping, and general safety shall be in accordance with Section 3.3.6.5.2.2.3 of FAA-G-2100F.

3.3.1.12.9.4 Class IV - Fire and Emergency Classification

Signs that label and indicate the location of fire extinguishing equipment, shutoffs, emergency switches, and emergency procedures shall be in accordance with Section 3.3.6.5.2.2.4 of FAA-G-2100F.

3.3.1.13 Human Factors Engineering

When establishing general and detailed design criteria, elements affecting safety shall be engineered with consideration given to human factors. The designs shall eliminate or mitigate hazards associated with:

a. Hazardous components,

b. Safety-related interface considerations between the equipment and other portions of the system,

c. Environmental constraints including the operating environment,

d. Operating, test, maintenance, and emergency procedures,

e. Facilities and support equipment, and

f. Safety related equipment, safeguards, and possible alternate approaches.

3.3.1.14 Personnel Safety and Health

The design and development of electronic equipment shall provide for the safety of personnel during the installation, operation, maintenance, repair, and interchange of complete equipment assemblies or component parts. Equipment design for personnel safety shall be equal to or better than the requirements of the Occupational Safety and Health Agency (OSHA) as identified in CFR Title 29, Part 1910 and Part 1926.

3.3.1.14.1 Electrical Safety

Personnel shall be protected with respect to electrical contact in accordance with Section 3.3.6.1 of FAA-G-2100F.

3.3.1.14.1.1 Ground Potential

Grounding of external parts, surfaces, and shields shall be in accordance with Section 3.3.6.1.1 of FAA-G-2100F.

3.3.1.14.1.2 Hinged or Slide Mounted Panels and Doors

Hinged or slide mounted panels and doors shall be grounded in accordance with Section 3.3.6.1.2 of FAA-G-2100F.

3.3.1.14.1.3 Shielding

Shielding on wire and cable shall be grounded in accordance with Section 3.3.6.1.3 of FAA-G-2100F except when a conflict with the grounding requirements of Section 3.3.1.9.15 would be created.

3.3.1.14.1.4 Radio Frequency Voltage Protection

Personnel shall be protected from accidental contact with transmitter output terminals, antennas, and devices that carry sufficient RF voltage to cause injury.

3.3.1.14.1.5 Electrical Connectors

Electrical connectors shall comply with Section 3.3.6.1.12 of FAA-G-2100F.

3.3.1.14.2 Radio Frequency Limits

3.3.1.14.2.1 Radiation Hazards and Protection

All electronic equipment or electrical devices capable of emitting x-radiation or RF/microwave radiation between 300 kHz and 100 GHz shall be designed, fabricated, shielded, and operated to the requirements of FAA Order 3900.19B.

3.3.1.14.3 Cathode Ray Tubes

Cathode ray tubes shall conform to the requirements of UL Standard 1418, where applicable.

3.3.1.15 Hazardous and Restricted Materials

Assessment of the hazard potential of a substance and its decomposition products shall be performed before material selection. This assessment shall include those materials listed in Section 3.3.6.6 of FAA-G-2100F.

3.3.1.16 Federal Communications Commission Type Acceptance and Registration

The first production equipment shall be subjected to the Federal Communication Commission (FCC) type acceptance and registration procedures in accordance with the FCC Rules and Regulations of the CFR, Title 47, Part 2, Part 68, and Part 87. The environmental temperature range specified by the FCC shall supersede, for the purposes of the FCC Type Acceptance Procedures, the service condition temperature range that is applicable under the equipment specification and this specification. Compliance with FCC Regulations shall be maintained with regard to any approved changes made to the production equipment that is relevant to the FCC Type Acceptance or Registration.

3.3.2 CONTROL AND DISPLAY

All control and display units shall be in accordance with Human Factors guidelines, defined in Section 3.3.7 of FAA-G-2100F and Section 7 of the Human Factors Design Guide. In case of a conflict within these documents, the Human Factors Design Guide shall take precedence.

3.3.2.1 Local Status Panel

An LSP shall be installed as the on-site maintenance interface to the LGF. The LSP shall provide two female DB-9 connectors for the RMDT and MDT maintenance interfaces to the LGF.

3.3.2.1.1 LSP – Modes and Service Alerts

The LSP shall annunciate LGF operating status as follows:

a. Green for Normal,

b. Red for Not Available,

c. White for Test,

d. Orange for Service Alert.

The LSP shall display a change in mode and service alerts within 2 seconds of detection by the LGF.

3.3.2.1.1.1 LSP – Initialization

The LSP shall simultaneously annunciate green, red, white, and orange during a power-up, manual reset, or automatic restart, as a test to ensure all indicators are displaying properly. The LSP shall have a legible label to denote panel indicator functions.

3.3.2.1.2 LSP – Aural Signal

The LSP shall initiate a steady tone aural signal when the LGF is Not Available. The LSP shall initiate an intermittent beep aural signal when there is a service alert. Annunciating "Not Available" shall take precedence over a service alert. Aural signals shall be implemented in accordance with FAA Human Factors Design Guide Sections 7.3.1.5, 7.3.1.6, 7.3.2 (excluding sections 7.3.2.1.1 through 7.3.2.2.5), 7.3.3, and 7.3.4.

3.3.2.1.3 LSP – Silence Switch

Upon command, the LSP shall manually silence an aural signal. The LSP shall automatically reset the signal, once it has been silenced, until another alarm, service alert, or constellation alert occurs.

3.3.2.2 Remote Status Panel

As an external interface, an RSP shall be located within 50 miles of the airport. The RSP shall have two female DB-9 connectors for the RMDT and MDT maintenance interfaces to the LGF.

3.3.2.2.1 RSP – Modes and Service Alerts

The RSP shall annunciate LGF operating status as follows:

a. Green for Normal,

b. Red for Not Available,

c. White for Test,

d. Orange for Service Alert.

The RSP shall display a change in mode and service alerts within 2 seconds of detection by the LGF.

3.3.2.2.1.1 RSP – Initialization

The RSP shall simultaneously annunciate green, red, white, and orange during a power-up, manual reset, or automatic restart, as a test to ensure all indicators are displaying properly. The RSP shall have a legible label to denote panel indicator functions.

3.3.2.2.2 RSP– Aural Signal

The RSP shall initiate a steady tone aural signal when the LGF is Not Available. The RSP shall initiate an intermittent beep aural signal when there is a service alert. Annunciating "Not

Available" shall take precedence over a service alert. Aural signals shall be implemented in accordance with FAA Human Factors Design Guide Sections 7.3.1.5, 7.3.1.6, 7.3.2 (excluding sections 7.3.2.1.1 through 7.3.2.2.5), 7.3.3, and 7.3.4.

3.3.2.2.3 RSP – Silence Switch

Upon command, the RSP shall manually silence an aural signal. The RSP shall automatically reset the signal, once it has been silenced, until another alarm, service alert, or constellation alert occurs.

3.3.2.2.4 RSP – Supplementary Power

The RSP shall remain continuously powered for no less than two hours of uninterrupted operation via a supplementary power source after the loss of primary AC power. Restoration of primary power shall not negatively affect the operation of the respective subsystems.

3.3.2.3 Maintenance Data Terminal

An MDT shall be installed, interfacing to the LGF through the LSP and RSP, to a distance of 20 ft. All manually-entered data shall be stored in LGF NVM. The MDT shall have a Zip™ drive capable of supporting 250 megabyte cartridge. A computer virus check for malicious code shall be performed on any data to be transferred to the LGF via the MDT. Malicious code is defined as an unauthorized attempt to include software or firmware that is capable of corrupting the operation of the LGF. The MDT commands and monitors all test and maintenance actions available through the interface.

3.3.2.3.1 Restart

Upon command, the MDT shall restart the LGF. Commanding restart shall cause all program variables and all software and firmware-controlled hardware to be initialized to a pre-defined condition upon entering Normal Mode.

3.3.2.3.2 States and Modes Display

The MDT shall display the current LGF state and mode, defined in Section 3.1.4.

3.3.2.3.3 Alerts and Alarm Display

The MDT shall display, within 2 seconds, all alert and alarm messages generated by the LGF.

3.3.2.3.4 VDB Display

The MDT shall display the VDB status as either transmitting or not transmitting. The MDT shall display the VDB message type and data fields.

3.3.2.3.5 VDB Control

Upon command, the MDT shall activate and deactivate the VDB. VDB deactivate shall by-pass the VDB antenna and terminate into a dummy load.

3.3.2.3.6 VDB Message Data

Upon command, the MDT shall adjust the following VDB message data for each message type and parameter:

a. Message Header
    1. Reference Station ID
b. Type 1 Message
    1. Measurement Type
    2. Sigma Pseudorange Ground (Section 3.2.1.2.7.7)
    3. Ephemeris Decorrelation Parameter
c. Type 2 Message
    1. LGF Installed RRs
    2. LGF Accuracy Designator
    3. Local Magnetic Variation
    4. Refractivity Index
    5. Scale Height
    6. Refractivity Uncertainty
    7. Latitude
    8. Longitude
    9. Reference Point Height
    10. Sigma Ionosphere
    11. Reference Station Data Selector
    12. Maximum Use Distance
    13. Ephemeris Fault-Free Missed Detection Parameters
d. Type 4 Message
    1. Data Set Length
    2. FAS Data Block - manually entered as a block in its entirety:
        a) Operation Type
        b) SBAS Provider Identification
        c) Airport Identification

d) Runway Number
e) Runway Letter
f) Approach Performance Designator
g) Route Indicator
h) Reference Path Data Selector
i) Reference Path Identifier
j) LTP/FTP Latitude
k) LTP/FTP Longitude
l) LTP/FTP Height
m) Δ FPAP Latitude
n) Δ FPAP Longitude
o) Approach TCH Height
p) Approach TCH Unit Selector
q) GPA
r) Course Width
s) Δ Length Offset
t) FAS CRC

3. FAS VAL/Approach Status – Lateral Navigation (LNAV) Only
4. FAS LAL/Approach Status – Approach Not Available

3.3.2.3.7 System Power Display

The MDT shall display the LGF power source.

3.3.2.3.8 Alerts and Alarm Status Display

The MDT shall display the status of all existing alerts and alarms.

3.3.2.3.9 Alerts and Alarm Threshold Display

Upon command, the MDT shall display the thresholds and tolerances for alert, service alert, constellation alert, and alarm parameters, as defined in Sections 3.1.5.1.2, 3.1.5.1.3, 3.1.5.1.4, and 3.1.5.1.5.

3.3.2.3.10 Alerts and Alarm Threshold Control

Upon command, the MDT shall enable the modification of the thresholds for alert, service alert, constellation alert, and alarm parameters, as defined in Sections 3.1.5.1.2, 3.1.5.1.3, 3.1.5.1.4, and 3.1.5.1.5. Upon command, the MDT shall enable the modification of the defined thresholds, in minimum steps, within design tolerances. The MDT shall enable the manual input of all pre-defined thresholds within the design tolerances.

3.3.2.3.11 Monitor By-Pass

3.3.2.3.11.1 By-Pass Annunciation

Upon command, the MDT shall by-pass the aural annunciation of all alerts and alarms to the LSP, RSP, or ATCU, or all simultaneously while the LGF is in the Test Mode. The MDT by-pass annunciation function shall have a configurable default setting.

3.3.2.3.11.2 By-Pass Actions

Upon command, the MDT shall by-pass the VDB shut-down action associated with Section 3.2.3 item ‘b’.

Note: This capability is provided for maintenance purposes.

3.3.2.3.12 Static Site Data Display

Upon command, the MDT shall display the following site-specific parameters:

a. VDB Frequency,
b. VDB Power,
c. TDMA Time Slot(s),
d. RR Geodetic Coordinates,
e. Reception Mask,
f. σ_{rrc}, the one sigma range rate correction error.

3.3.2.3.13 Static Site Data Control

Upon command, the MDT shall enable the input of the following site-specific parameters:

a. VDB Frequency, 108.025 MHz to 117.975 MHz in 25 kHz channels,
b. VDB Power Adjustment,
c. TDMA Time Slot(s),
d. RR Geodetic Coordinates (WGS-84),
e. Reception Mask,
f. σ_{rrc}, the one sigma range rate correction error.

3.3.2.3.14 Approach Status Display

The MDT shall simultaneously display the approach status for up to 16 runway ends. The MDT shall display the enable, disable, and Lateral Navigation (LNAV) status of each runway end supported by the LGF.

3.3.2.3.15 Approach Control

Upon command, the MDT shall simultaneously enable all approaches associated with each runway end served by the LGF. Upon command, the MDT shall simultaneously disable all approaches associated with each runway end served by the LGF. The MDT shall enable or disable all approaches to a runway end with a single action.

3.3.2.3.16 Redundant Equipment Status Display

The MDT shall display the status for both classifications of LGF equipment, Main and Standby. Main and Standby equipment and the possible status shall be:

a. Main – Primary LGF Equipment
    1. On-line – Primary LGF equipment is on-line and operational.
    2. Failed – Equipment has failed and is not available for operational use.
    3. Disabled – Equipment has been disabled.
b. Standby – Backup/redundant LGF Equipment
    1. Available – Equipment is functional and is available for switchover following a main equipment failure.
    2. Failed – Equipment has failed and is not available for operational use.
    3. Disabled – Equipment has been disabled.
    4. On-line – Backup/redundant LGF equipment in on-line and operational.

3.3.2.3.17 Redundant Equipment Control

Upon command, the MDT shall change the classification of the LGF equipment as indicated in Section 3.3.2.3.16.

3.3.2.3.18 Diagnostics Display

The MDT shall display diagnostic results following a failure or a manual initiation. The MDT shall have on-screen help in order to perform diagnostics and other maintenance related actions.

3.3.2.3.19 Diagnostics Control

The MDT shall enable manually-initiated diagnostics. This shall include both Non-intrusive and Intrusive maintenance actions, as follows:

a. Non-intrusive diagnostics do not affect the current LGF operation.
b. Intrusive diagnostics may affect the LGF operation or require a re-certification Flight Check.

3.3.2.3.20 Temperature Display

The MDT shall display the temperature inside and outside of the LGF equipment facility.

3.3.2.3.21 Adjustment Storage

Before log-off, MDT-entered settings and adjustment shall be confirmed and the values stored in LGF NVM.

3.3.2.3.22 Processing and Memory Load Display

The MDT shall display the processor and memory loading factors and error sensing and reporting as defined in Section 3.3.1.2.

3.3.2.4 Air Traffic Control Unit

A primary ATCU, and at least one secondary ATCU, as part of the LGF standard configuration, shall be installed as an external interface in control towers and terminal and en route radar facilities at locations up to 3000 miles from the LGF. The ATCU shall work with up to 10 secondary ATCUs. The primary and secondary ATCUs shall be identical in form, fit, and function.

3.3.2.4.1 ATCU - Approach Control

Upon command, the ATCU shall simultaneously enable all approaches associated with any individual runway end served by the LGF. Upon command, the ATCU shall simultaneously enable all approaches associated with any individual runway end at a single airport served by multiple LGFs. Upon command, the ATCU shall enable or disable all approaches to a runway end with a single action. The ATCU shall be site adaptable to each airport landing runway configuration. Upon command, the ATCU shall display up to 6 landing runway configurations in accordance with the airport's runway use plan. Upon command, the ATCU shall enable/disable approaches for each landing runway configuration.

3.3.2.4.2 ATCU – Operational Status Display

The ATCU shall display the current enabled (including LNAV only) approach ends in the status display screen. Upon command, the ATCU shall simultaneously display the operational status for up to 16 runway ends. This shall include notice that the runway end is either enabled, disabled, or LNAV Only. "LNAV Only" shall be displayed when the vertical guidance for a runway end is disabled.

3.3.2.4.3 ATCU - Modes

The ATCU shall display "Category I," corresponding to the Normal Mode defined in Section 3.1.4.3. The ATCU shall display "Not Available," corresponding to the Not Available Mode defined in Section 3.1.4.4 or when in the Off State. The ATCU shall display changes in modes within 2 seconds of detection by the LGF.

3.3.2.4.4 ATCU - Maintenance Display

When the LGF is in the Test Mode, the ATCU shall simultaneously display “Test” and “Not Available.” No other indications shall be displayed.

3.3.2.4.5 ATCU Alert Display

The ATCU shall display a constellation alert within 2 seconds from the time of prediction. The ATCU shall display the start time and the end time of the predicted outage. The ATCU shall indicate when the service is available.

3.3.2.4.6 Aural Signal

The ATCU shall initiate a brief (like a “chirp”), intermittent (approximately every 1.5 seconds) aural signal for all LGF mode changes. The ATCU shall initiate a brief, intermittent aural signal for all three stages of a constellation alert: the initial warning of constellation loss, the actual constellation loss, and when the service becomes available. The aural signals sounded by the ATCU shall not change in pitch, as measured in cycles per second. Aural signals shall be implemented in accordance with FAA Human Factors Design Guide, Sections 7.3.1.5, 7.3.1.6, 7.3.2 (excluding sections 7.3.2.1.1 through 7.3.2.2.5), 7.3.3, and 7.3.4.

3.3.2.4.6.1 Audio Control

The ATCU shall manually control an aural signal with a range from low, but not silenced, to audible over ambient noise levels. Ambient noise levels in current controller environments range between 63 and 79 dB, with a mean of 67.7 dB. The ATCU shall have a switch, to be labeled “Silence,” that acknowledges, silences, and resets the aural signal until a change in mode, or a constellation alert occurs.

3.3.2.4.7 Design Requirements

The ATCU design shall have transfer and lockout control between the primary ATCU and the secondary ATCUs. All ATCUs shall be configurable to lock out control functions and provide status display only. All ATCUs shall have visual and aural annunciation for changes and updates of LGF status information.

3.3.2.4.7.1 Monitor Design Requirements

The ATCU monitor shall comply to the following requirements:

a. Configurable for the following physical environments, including:
    1. Rack-mounted in standard 19" equipment racks,
    2. Flush-mounted into the control tower console, terminal radar approach control (TRACON), and air route traffic control center (ARTCC),
    3. Set-up as an independent workstation.
b. Display screen attributes:

1. 14" (diagonal) color flat screen LCD,
2. A resolution of at least 800 x 600 pixels and 72 Dots Per Inch (dpi),
3. Refresh rate of more than 70 Hz,
4. Viewing angle at least 160° in vertical and horizontal planes,
5. Equipped with a touch screen input, in accordance with the guidelines of the Human Factors Design Guide, Section 8.8.4.2
6. Visible under all control tower lighting conditions, including direct sunlight and night operations,
7. Luminescence rating ranging from ≥ 40 nits to ≤ 900 nits,
8. Anti-glare treatment that does not reduce available light to less than 800 nits at the highest brightness setting.

c. External components and controls, including:
   1. Speaker,
   2. Volume control,
   3. Brightness control.

The luminescence rating for the ATCU monitor shall be verified under actual operating conditions.

The ATCU monitor shall default to a standard resolution of not less than 800 x 600 pixels in the event of a power failure. The ATCU monitor shall store the last used resolution internally. The ATCU monitor shall store configuration and calibration settings for resolution when the LGF performs a cold boot.

3.3.2.5 NAS Infrastructure Management System (NIMS) (RMDT)

The LGF-to-NIMS interface, either embedded or via a proxy agent, shall be developed on the NAS-IR-51070000, “Interface Requirements Document for NIMS Manager/Managed Subsystem,” where applicable.

The LGF-to-NIMS interface shall be configurable, in accordance with the logical access controls stated in Section 3.3.1.9.2.4, to limit functions to read-only and limited write capability, depending on the criticality of the function to be performed.

3.3.2.5.1 Monitoring Operations

The LGF-to-NIMS interface shall provide all monitoring functions, as specified in Section 3.3.2.3.

3.3.2.5.1.1 User Monitor

The RMDT shall report all users logged onto the LGF and corresponding security level.

3.3.2.5.2 Control Operations

The LGF-to-NIMS interface shall provide all control functions, as specified in Section 3.3.2.3.

3.3.2.5.2.1 Command Execution

The LGF-to-NIMS interface shall provide a response to all control operations with a command result and an indication of command execution.

Note: Control Operations shall be provided as a CLIN cost option.

3.3.2.5.3 Communications

3.3.2.5.3.1 Protocol

The NIMS communications protocol shall be an Open Systems Interface in accordance with NAS-IC-5107000-4 (SNMPv3).

Note: Other Open Systems Interfaces shall require prior approval from the FAA.

3.3.2.5.3.2 MIB Information

The NIMS manager shall address and process the Management Information Base (MIB) information received from the LGF (embedded or proxy agent). The NIMS manager shall perform the functions of monitor and control on these data.

3.3.2.5.3.3 Dedicated Communications Line

The LGF-to-NIMS interface shall communicate directly to the NIMS manager via a dedicated communications line. The dedicated line shall be capable of T1 and dial-up service.

3.3.2.5.3.4 Connection Speed

The LGF-to-NIMS interface connection, via an internal modem, shall include adjustable speeds of 2.4, 4.8, 9.6, 19.2, and 33.6 Kbps.

3.3.2.5.3.5 Asynchronous Connections

The LGF-to-NIMS interface connection, via an internal modem, shall provide for asynchronous connections with full duplex transmissions.

3.3.2.5.4 Industry Software

3.3.2.5.4.1 Commercial Software Tools

The LGF-to-NIMS interface shall use commercially available software tools for the development and coding of the operational software.

3.3.2.5.4.2 Non-Proprietary Operating System

The LGF-to-NIMS interface shall use a Non-Proprietary Operating System for the embedded or proxy agent.

3.3.2.5.4.3 Point-to-Point Protocol (PPP)

The LGF-to-NIMS interface shall use a version of PPP communications software, or an internal PPP daemon, for communications.

3.3.3 RECORDING

Filtering of repetitive events shall be permitted, with the most recent event logged with an indication of the start of the event. Commands to write over or delete any of the data sets in Sections 3.3.3.1, 3.3.3.2, 3.3.3.3, and 3.3.3.4 shall not be permitted. The LGF NVM used to store data shall be secure at all times from tampering and manipulation.

3.3.3.1 System Events

The LGF shall maintain a chronological record in NVM of the previous 90 days of date, time, inside and outside temperature, log-on, log-off, alert, service alert, constellation alert, and alarm events. The MDT shall display system events records.

3.3.3.2 Events Recording

The LGF shall utilize the data from the sigma monitor, Section 3.2.1.2.8.7.3, to indicate the hourly, daily, monthly, and yearly characteristics of the error in the broadcast correction. The data shall be recorded in NVM and exportable to the MDT and displayed on control chart(s) that includes alerts, service alerts, alarms, and action lines.

3.3.3.3 VDB Recording

The LGF shall automatically record all data broadcast parameters for a period not less than 48 hours. This data shall be exportable via a standard, commercially available electronic media. One 48-hour block of data shall be stored in NVM concurrently while the current 48-hour block of data is being recorded. At the end of each 48-hour period, the data stored from the previous 48 hours can be deleted and replaced with the current block of data. Four time windows for one, 24-hour period shall be selectable to capture any requested VDB field(s). This shall be programmable for up to one-week prior, and shall not interfere with the other recording requirement.

3.3.3.4 Reference Receiver Data

The LGF shall automatically record RR data for all RRs for a period not less than 48 hours. This data shall be exportable via a standard, commercially available electronic media. One 48-hour block of data shall be stored in NVM concurrently while the current 48-hour block of data is being recorded. At the end of each 48-hour period, the data stored from the previous 48 hours can be deleted and replaced with the current block of data. Recorded RR data shall include at a minimum:

a. L1 carrier phase with a resolution of 0.01 cycles,

b. L1 C/A code pseudorange with a resolution of .01 meter or better, and

c. Broadcast navigation data for all tracked GPS ranging sources.

Upon command from the MDT, the recording function shall be terminated for a period not to exceed 30 minutes.

3.3.4 INTERFACE REQUIREMENTS

3.3.4.1 LSP Interface

The vendor shall define all LSP data interface requirements. The LSP interface to the MDT shall conform to EIA/TIA-232-E, Interface Between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange (Electronic Industries Association, July 1991).

3.3.4.2 RSP Interface

The vendor shall define all RSP data interface requirements. The RSP interface to the MDT shall conform to EIA/TIA-232-E.

3.3.4.3 MDT Interface

The MDT interface shall conform to EIA/TIA-232-E.

3.3.4.4 RMDT Interface

The RMDT interface shall conform to EIA/TIA-232-E.

3.3.4.5 ATCU Interface

The vendor shall define all ATCU and secondary ATCU interface requirements. The interface characteristics shall be commercially available and in accordance with ISO standards and recommendations.

4. VERIFICATION

4.1 TEST PROGRAM

The testing and test activities of inspection, analysis, and demonstration assure that LGF hardware, software, and system requirements have been fully satisfied in accordance with the Acquisition Management System Test & Evaluation Process Guidelines (FAA, July 1997). These guidelines minimize reliance on explicit policies defining the conduct of test and evaluation. Practical testing appropriate to each acquisition is strongly supported. The qualification requirement verification process specified herein is in accordance with the guidelines.

Operational Test (OT) shall be conducted in support of the acceptance of the LGF in accordance with the requirements of this specification and operational requirements of the LAAS RD. OT is normally conducted with contractor support at the designated FAA test facility; the FAA William J. Hughes Technical Center (WJHTC). Development Test (DT), Production Acceptance Test (PAT), and Site Acceptance Test (SAT) are performed at the contractor facility and should reference the Verification Requirements Test Matrix (VRTM) in Appendix C.

4.1.1GENERAL TESTING REQUIREMENTS

4.1.1.1 Development Test

DT activities shall be conducted to verify that the implemented hardware and software design meet the functional and performance requirements of the LGF specification. Specific tests for verification are not conveyed, but normally include the verification of software and hardware requirements, stability and dry running, and system level testing.

4.1.1.2 Production Acceptance Test

PAT shall be performed on each end-item before it leaves the factory to verify that the end-item conforms to applicable requirements, is free from manufacturing defects, and is substantially identical to the qualified system.

4.1.1.3 Site Acceptance Test

SAT is conducted after completion of hardware installation and checkout and the installation has been inspected and approved for workmanship and configuration. SAT is accomplished initially for the developmental system, and is repeated for each production system after PAT. Contractor-conducted testing shall be performed at each field site to verify that the new system is installed and operating properly on site.

4.1.1.4 Verification Methods

The LGF Test Program shall use the verification methods of Inspection (I), Analysis (A), and Test (T). These methods are defined as follows:

a. I – Inspection is a method of verification to determine compliance with specification requirements and consist primarily of visual observations, mechanical measurements of the equipment, physical locations, and technical examination of engineering-supported documentation.

b. A – Analysis is a method of verification that consists of comparing hardware or software design with known scientific and technical principles, technical data, or procedures and practices to validate that the proposed design will meet the specified functional and performance requirements. Analysis also includes the use of modeling and simulation.

c. T – Test is a method of verification that will measure equipment performance under specific configuration-load conditions and after the controlled application of known stimuli. Quantitative values are measured, compared against previous predicted success criteria, and evaluated to determine the degree of compliance.

4.1.2 RELIABILITY TEST

The test shall consist of testing at least 2 standard configuration LGFs, as defined in Section 3.3.1.1, for a minimum of 1400 hours each, for a total of 2800 accumulated hours. One half of the test shall be performed at 25 degrees Centigrade, one fourth at 50 degrees Centigrade and one fourth at Minus 10 degrees Centigrade. Any Line Replaceable Unit (LRU) or Hardware Configuration Item (HWCI) specified to have a MTBF of more than 5,000 hours shall exhibit no relevant failures during the 2800 accumulated hours test. Any relevant failure as defined in MIL-STD-781, paragraph 4.7 through 4.7.4 shall constitute a failed reliability test. Any LRU or HWCI with a specified MTBF of 5,000 hours or less shall not experience more than one relevant failure during the 2800 hour test. The failure shall be corrected and the test continued for an additional 1,000 hours. Any relevant failures occurring during this 1,000 hour period shall constitute a failed reliability test.

Appendix A
Interference Environment

The interference environment is referenced in Appendix D of the LAAS MOPS (RTCA/DO-253A).

Appendix B

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Appendix C
Verification Requirements Traceability Matrix

		Verification Level and Method			
Paragraph	**Requirement**	**DT**	**PAT**	**SAT**	**Remarks**
3.1	LAAS Ground Facility General Requirements				Section Header, No Test Requirements
3.1.1	Coverage Volume	T	T	T	
3.1.2	Integrity	A			
3.1.3	Continuity	A, T			
3.1.4	States and Modes	I	I	I	
3.1.5	Executive Monitoring	I, A, T			
3.1.6	Software Design Assurance	I, T			
3.1.7	Complex Electronic Hardware Design Assurance	I			
3.2	Data Broadcast				Section Header, No Test Requirements
3.2.1	Broadcast Data Requirements	I, T	I, T	I, T	
3.2.2	RF Transmission Characteristics	I, T	T		
3.2.3	RF Broadcast Monitoring	T	I		
3.3	Operation and Maintenance				Section Header, No Test Requirements
3.3.1	System Requirements				Section Header, No Test Requirements

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
3.3.1.1				LGF Configurations	I			
3.3.1.2				Computer Resource Reserve Capacity	I, T			
3.3.1.3				Environmental Design Values	T			
3.3.1.4				Primary Power	T	T		
3.3.1.5				Supplementary Power	T	T	T	
3.3.1.5.1				Power Supply	T	T	T	
3.3.1.6				Environmental Sensors	I, T	I	I	
3.3.1.7				Fault Diagnostics	T	T	T	
3.3.1.8				Maintainability of Electronic Equipment				Section Header, No Test Requirements
3.3.1.8.1				Maintenance Concept	I			
3.3.1.8.2				Availability	T			
3.3.1.8.3				Reliability	T			
3.3.1.8.4				Maintainability	T			
3.3.1.8.5				System Specialist workload	I, A			
3.3.1.9				Security	I			
3.3.1.10				Physical Design and Packaging	A ,I			
3.3.1.11				Electrical	I			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	Remarks
3.3.1.12				Markings	I			
3.3.1.13				Human Factors Engineering	A, I			
3.3.1.14				Personnel Safety and Health	A, I			
3.3.1.15				Hazardous and Restricted Materials	A,I			
3.3.1.15				FCC Type Acceptance and Registration	T			
3.3.2				Control and Display	I	I	I	Title
3.3.2.1				Local Status Panel	I	I	I	
3.3.2.2				Remote Status Panel	I			
3.3.2.3				Maintenance Data Terminal	I	I	I	
3.3.2.4				ATCU	I	I	I	
3.3.2.5				NIMS (RMDT)	I	I	I	
3.3.3				Recording	I	I	I	
3.3.4				Interface Requirements	I			

Appendix D
Acronyms

Appendix E
Special Conditions for Ground and Air

The airborne receiver is assumed to be operating fault free and meeting all the performance requirements in the LAAS MOPS (RTCA/DO-253A). Section 3.1.2.2 is assumed to meet the 1 x 10^{-5} prior probability of a RR failure as part of satisfying the the H_1 VPL/LPL equation.

Signal deformation is defined to be any GPS ranging source that is distorted as given by the following threat model:

1. Each falling edge of the positive chips in the C/A code is delayed by Δ seconds, where $0 \leq \Delta \leq 120$ nanoseconds.

2. Each falling edge of the positive chips in the C/A code is advanced by Δ seconds, where $0 \leq \Delta \leq 120$ nanoseconds.

3. The distorted C/A code is the output of a second order linear system that has the standard C/A code as an input. The system is characterized by a damping factor, σ, and a resonant frequency, f_d, as shown:

$$\xrightarrow{\text{C/A Code}} \boxed{\frac{(2\pi f_0)^2}{s^2 + 2\sigma s + (2\pi f_0)^2}} \xrightarrow{\text{Distorted C/A Code}} \tag{1}$$

where $f_0 = \frac{1}{2\pi}\sqrt{\sigma^2 + (2\pi f_d)^2}$ and (2)

s is the complex frequency used in Laplace transforms.

Each step, e_0, in the input C/A sequence results in a second order step response that is given by

$$e(t) = e_0\left\{1 - \exp(-\sigma t)\left[\cos 2\pi f_d t + \frac{\sigma}{2\pi f_d}\sin 2\pi f_d t\right]\right\}, \tag{3}$$

for this waveform,

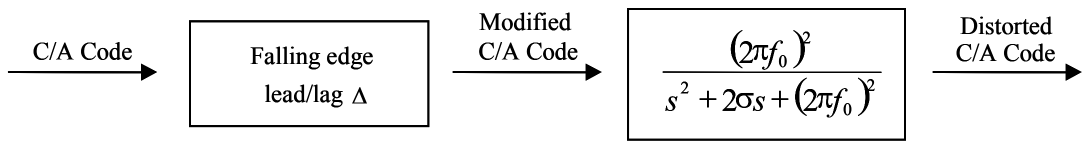
$0.8\text{x}10^6 \leq \sigma \leq 8.8\text{x}10^6$ nepers/second

$4\text{x}10^6 \leq f_d \leq 17\text{x}10^6$ cycles/second.

4. The distorted C/A code is the output of a second order linear system characterized by a damping factor and a resonant frequency with an input of a modified standard C/A code, where every falling edge of the positive chip in the modified C/A code is:

a) Delayed by Δ seconds, where $0 \leq \Delta \leq 120$ nanoseconds

b) Advanced by Δ seconds, where $0 \leq \Delta \leq 120$ nanoseconds



(4)

This waveform has the combined effects of items 1, 2, and 3, but the damping factor and resonant frequency are varied over a smaller range, specifically:

$$0.8\text{x}10^6 \leq \sigma \leq 8.8\text{x}10^6 \text{ nepers/second}$$
$$7.3\text{x}10^6 \leq f_d \leq 13\text{x}10^6 \text{ cycles/second.}$$

No threat model for SBAS is defined.

The parameters are based on the airborne tracking constraints defined in LAAS MOPS.

Appendix F
Usage of LGF Test and Alarm Indicators

Several fields in the VHF data broadcast can indicate that an approach is unusable. This appendix describes those fields and how they are used.

F-1. Message Block Identifier

The message block identifier is part of the message header and is part of each message broadcastThe LGF will broadcast Type 1, Type 2 and Type 4 messages. When the message block header is 1010 1010, it is an indication that the message can be used for navigation. When the message block header is 1111 1111, it is an indication that the message can not be used for navigation and is officially called a "Test" message. The LGF specification requires a "Test Mode" in which test conditions can be run or the system is undergoing maintenance that may cause the conditions of the LGF radiated signal to be out of tolerance. Flight inspection avionics will have the capability to override the test message block header to flight check the LGF signal without concern that the flying public may use the signal. This capability is similar to removing the ident from a VOR or ILS facility.

F-2 Blank Type 1 Messages

The Type 1 message provides a "Number of Measurements" field which indicates the number of pseudorange corrections contained in the message. When this field is set to zero, the LAAS airborne receiver can not use differential corrections from the LGF and therefore all LGF-based operations cease. This message field will be utilized to indicate an alarm at the LGF. The time from when the fault is detected to when it is annunciated at the aircraft includes the fact that the Type 1 message is broadcast at 2 Hz.

F-3 Ground Continuity Integrity Designator

The Ground Continuity Integrity Designator (GCID) Field is contained in the Type 2 message and indicates the operational status of the LGF. This specification addresses Category I precision approaches and indicates this with a GCID value of 1. The LGF indicates a value of 7 for the GCID when the ground station signal does not comply with the Category I requirements for integrity and continuity. It is important to note that while the LGF may be in Test mode, the LGF can change the GCID according to the actual performance level of the signal. If a fault in the LGF has been corrected, maintenance or flight inspection may prefer to perform additional checks of the system while in Test, and a true indication from the GCID of the actual performance must be provided. If the GCID is broadcasting 1, for Category I precision approach, then maintenance will be assured that corrections are included in the broadcast and not have to monitor the VDB messages. Conversely, a GCID of 7 indicates that the system is still unusable and the Number of Measurements Field has been set to zero.

Appendix G
Risk Allocation Trees

LAAS LGF Integrity Risk Allocation (Precision Approach)

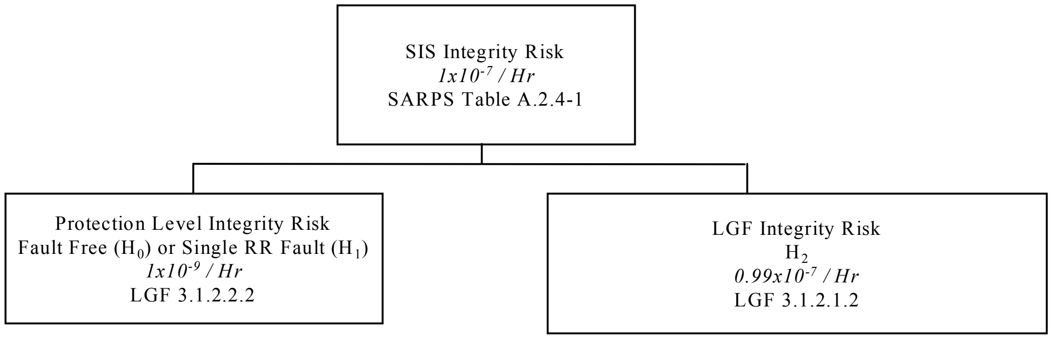
Note: Exposure time is150 seconds (MASPS 3.1.2.2).

SIS Integrity Risk
$2x10^{-7}$ / approach
MASPS 3.1.2.2

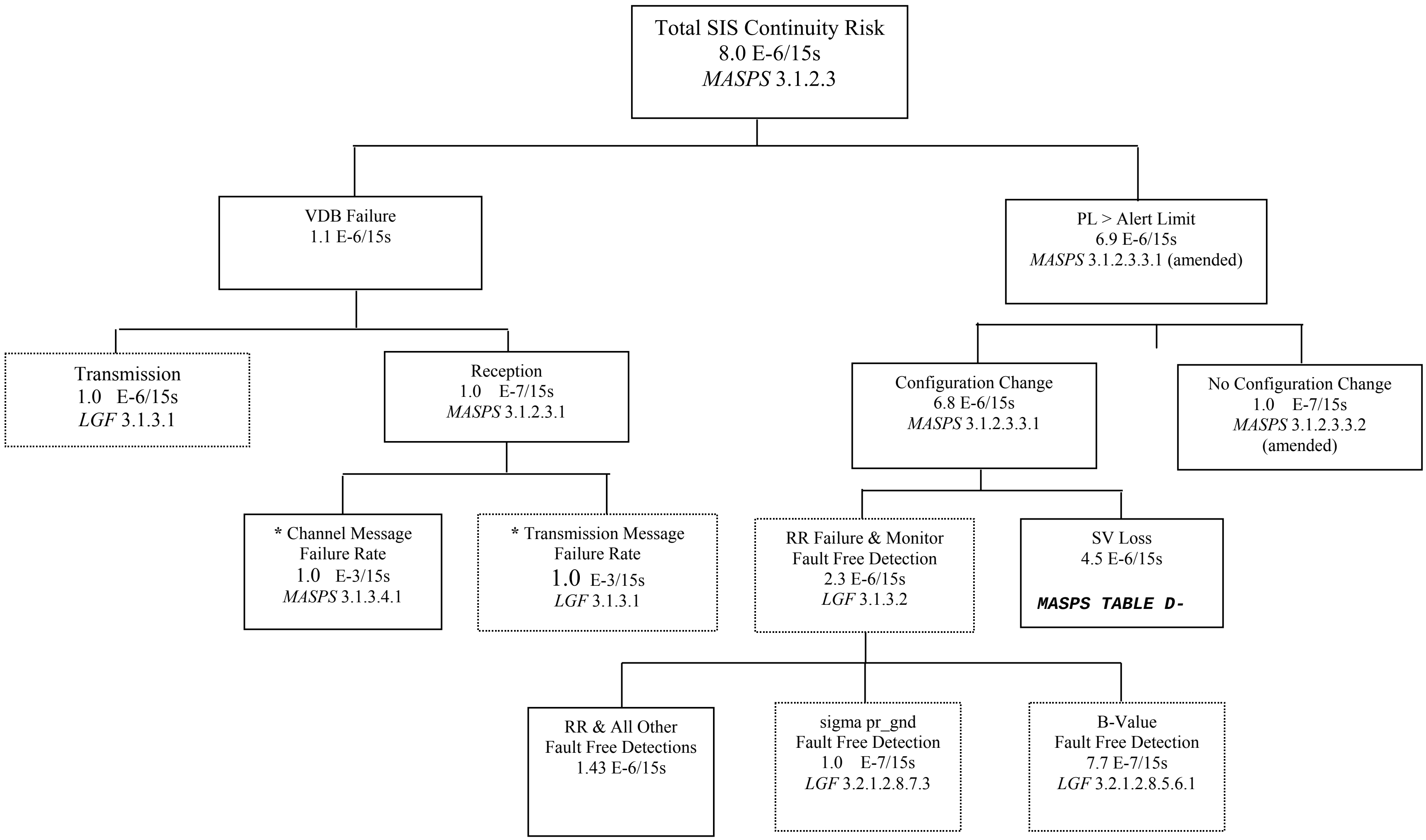
Protection Level Integrity Risk
Fault Free (H_0) or Single RR Fault (H_1)
$0.5x10^{-7}$ / approach
LGF 3.1.2.2.1

LGF Integrity Risk
H_2
$1.5x10^{-7}$ / approach
LGF 3.1.2.1.1

Appendix G
LAAS LGF Integrity Risk Allocation (Differentially Corrected Positioning Service)



Continuity Risk Allocations



* Note: These requirements are assigned to increase the reliability of the VDB and are not specifically included to ensure continuity.

Appendix H
Final Approach Segment – Definitions

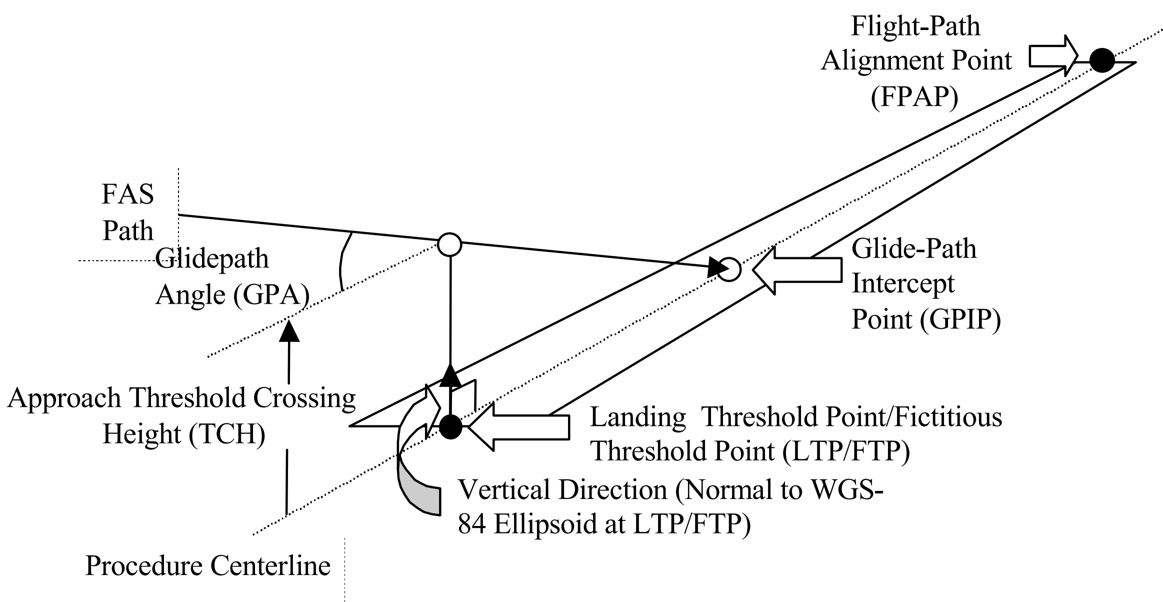


Figure H-1. Final Approach Segment Diagram

H – 1. Final Approach Segment Path Definition

The Final Approach Segment (FAS) path is a line in space defined by the Landing Threshold Point/Fictitious Threshold Point (LTP/FTP), Flight Path Alignment Point (FPAP), Threshold Crossing Height (TCH) and the Glide Path Angle (GPA). The local level plane for the approach is a plane perpendicular to the local vertical passing through the LTP/FTP (i.e., tangent to the ellipsoid at the LTP/FTP). Local vertical for the approach is normal to the WGS 84 ellipsoid at the LTP/FTP. The Glide Path Intercept Point (GPIP) is where the final approach path intercepts the local level plane.

H – 2. LTP/FTP Definition

The Landing Threshold Point/Fictitious Threshold Point (LTP/FTP) is a point over which the FAS path passes at a relative height specified by the threshold crossing height. It is normally located at the intersection of the runway centerline and the threshold.

H – 3. Final Path Alignment Point Definition

The Flight Path Alignment Point (FPAP) is a point at the same height as the LTP/FTP that is used to define the alignment of the approach. The origin of angular deviations in the lateral direction is defined to be 305 meters (1000 ft) beyond the FPAP along the lateral FAS path. For an approach aligned with the runway, the FPAP is at or beyond the stop end of the runway.